CAL POLY CLIMATE ACTION PLAN

Prepared By:
City & Regional Planning 410/411 Studio
May 2016

CAL POLY
CLIMATE ACTION PLAN

Prepared For:
Cal Poly Facility Management and Development

Prepared By:
City & Regional Planning 410/411 Studio

Instructors:
Adrienne I. Greve, Chris W. Clark, & William W. Riggs

Graduate Students:
Jesse A. Carpentier, Curran K. Lord-Farmer

PolyCAP Team:

Samuel Anderson
Miriam Arias
Tara Ash-Reynolds
Alan Ayon
Shannon Boston
Gustavo Castro
Roberto Contreras
Rachel Du Mont
Emily Foley
Nichole Garner
Augustus Grochau
Alex Hunt
Camille Jackson
Spencer Johnson
Jade Kim
Thomas Kobayashi
Lauren Leedeman
Mark Manha
Emilie Morse
Steven Orozco
Emma Peterson
Rachel Raynor
Tanner Shelton
Garrett Wank
Matt Wiswell
Jerome Wu
Rebecca Wysong

Acknowledgments

The City & Regional Planning 410/411 studio would like to thank the many students, faculty, and staff that have supported development of the climate action plan. In particular, we thank the following individuals and organizations for their guidance and support through the development of this Climate Action Plan. This undertaking would not have been possible without their time, knowledge, and advice.

Eric Veium
Dennis Elliot
Stacey White
Aaron Lazanoff
Scott Steinmaus
Johnny Rosecrans
Beth Reynolds
Kevin Piper
Marlene Cramer
SLO Transit
Ron Hostick
Kim Busby-Porter
G. Yau
Scott Bloom
Carol Schaffer

Table of Contents:

Acronym List:

Agricultural Operations (Ag. Ops.)
California Polytechnic State University, San Luis Obispo (Cal Poly)
California State University (CSU)
Cal Poly Emergency Management Multi-Hazard Preparedness Plan (CP EMP)
City and Regional Planning (CRP)
Cal Poly Climate Action Plan (PolyCAP)
College of Agriculture, Food, and Environmental Sciences (CAFES)
Emergency Operation Center (EOC)
Environmental Impact Report (EIR)
Facilities Management and Development (FM&D)
Greenhouse gas (GHG)
Horticulture Crop Science (HCS)
Kilowatt (kW)
Megawatts (MW)
Metric tons of carbon dioxide equivalent (MTCO2e)
Megawatt hours (MWH)
Million Gallons (MG)
Photovoltaic (PV)
Pacific Gas & Electric (PG&E)
Renewable Energy Self-Generation Bill Credit Transfer Program (RES-BCT)
San Luis Obispo (SLO)
University of California San Diego (UCSD)
University of California Santa Cruz (UCSC)
Vehicle miles traveled (VMT)
Water Resource Recovery Facility (WRRF)

Sector Icons:

Agriculture ***Buildings*** ***Campus Life*** ***PPP*** ***Renewable Energy***

Solid Waste ***Transportation*** ***Water***

Introduction

Introduction

The Cal Poly Climate Action Plan (PolyCAP) is designed to achieve the California State University (CSU) Chancellor's mandate to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020 and 80% below 1990 levels by 2040 (CSU, 2014). California Polytechnic State University, San Luis Obispo (Cal Poly) Facility Management and Development (FM&D) and the City and Regional Planning (CRP) Senior Community Planning Laboratory developed the PolyCAP during the Fall 2015 and Winter 2016 quarters, with editing and refinement in subsequent quarters. The goal of the PolyCAP is to reduce Cal Poly's GHG emissions and to adapt the Campus to a changing climate. The PolyCAP aims to exceed the CSU mandate and achieve Net Zero GHG emissions by 2050, in accordance with Cal Poly's signing of the Second Nature Climate Commitment. Cal Poly is updating its Master Plan to 2035, examining University academics, buildings, housing, transportation, agriculture, and more. The PolyCAP is intended to aid the Draft Master Plan Update to achieve its goal to be responsive to climate change. Many strategies of the PolyCAP can also be implemented as mitigation measures in the Draft Master Plan Update Environmental Impact Report (EIR).

1. Background

1.1 Climate Change Summary

Climate change is understood as an increase in the average global temperature (global warming), but it also includes the changing of patterns of temperature, precipitation (rain and snow), wind, sea level, and ocean acidification. The primary cause of these changes is the greenhouse effect that results from increased atmospheric concentrations of GHGs, the most common being carbon dioxide. GHGs are produced in a number of different ways, including the burning of fossil fuels in cars, factories, and the production of electricity.

1.2 Inventory Summary

The Cal Poly Greenhouse Gas Inventory used to calculate emissions and reductions in the PolyCAP was completed by Dr. Adrienne Greve, Dr. William Riggs, and City and Regional Planning graduate students in the summer of 2015. Each emissions area in the GHG Inventory had a compiled list of current emissions produced by their respective sectors for the baseline year of 2014. The GHGs the inventory measured are Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O). For sectors in the PolyCAP such as Renewable Energy, Water, and Buildings, emissions are measured based on the use of electricity (kilowatts, kWh) and provision of thermal units (Therms). All GHG emissions associated with these energy sources were converted to metric tons of Carbon Dioxide equivalents (MTCO2e) for ease of comparison.

1.3 Background Report Summary

The Background Report for the PolyCAP was created in order to assess the current conditions of Cal Poly's campus. The Report allowed students to gain an understanding of what the Cal Poly Climate Action Plan needs to address. A policy audit reviewed existing federal, state, and local policy to understand how current conditions were produced. In addition, the Background Report gathered best practices from various sources in order to understand what has worked for other entities and jurisdictions that could potentially work for the Cal Poly campus. A vulnerability assessment was developed to analyze the aspects of climate change that are predicted to affect the Cal Poly campus. The Background Report set the stage for the development of the PolyCAP.

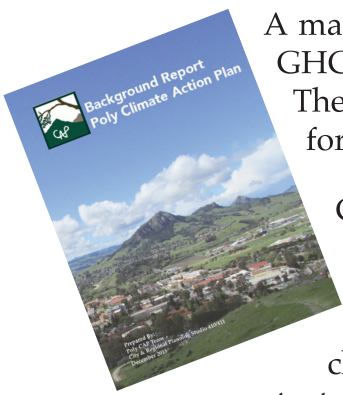
Best Practice

The PolyCap team reviewed existing federal, state, and local climate policies, as well as other guidance documents to develop a more comprehensive Climate Action Plan. This exercise helped the team to understand how other Universities, cities, and communities were addressing climate change. These resources were evaluated to identify policies suitable for Cal Poly. Each team reviewed literature on GHG reduction strategies specific to their sector and used those as guidelines for policy development. Policies that were easily implementable and had significant GHG reduction were prioritized, but all feasible reduction strategies were considered. The projected GHG reduction and cost of implementation was considered for each proposed strategy to ensure that Cal Poly would meet the state and CSU emission thresholds.

Vulnerability Assessment

The Vulnerability Assessment section of the Background Report analyzed the climate impacts that are anticipated to affect Cal Poly. As a result of the location of Cal Poly in San Luis Obispo, California, the main issues found through this analysis were average temperature increases, drought, and an increased frequency in natural disasters. Temperature increases prompts a greater frequency of wildfires and shrinkage of water supply. California is currently in a prolonged drought. This decrease in water supply is seen to be a large potential problem for the campus. Additionally, natural disasters may increase the likelihood of events such as wildfires, flooding, and extreme storm events. Understanding Cal Poly's vulnerabilities is essential to creating a successful Climate Action Plan.

1.4 PolyCAP Development Process



A master list of GHG emissions emitted by Cal Poly, also referred to as a GHG inventory, is the first step necessary for writing a Climate Action Plan. The inventory for Cal Poly was assembled in 2015 and provides a baseline for reductions to be compared against.

Combining the previously discussed elements, the Background Report recounts the state of Cal Poly's current policies, the laws and policies impacting the University's future decisions and presents a vulnerability assessment highlighting the risks posed by climate change to the campus. The Background Report works to provide the context for the Climate Action Plan, as well as illustrate the risks posed by climate change and what the PolyCAP needs to address to help Cal Poly reach the goal of 80% below 1990 emissions level by 2040.

The Climate Action Plan gathers the information from the GHG Inventory and the Background Report to create the Climate Action Plan, a set of specific Goals, Objectives and Strategies for each campus sector. The presented framework prepares Cal Poly to Achieve the CSU mandate of reducing GHG emission to 80% below 1990 levels by 2040 and the campus goal to become a Net Zero campus by 2050. The document highlights specific emissions by sector, and provides a yearly inventory of GHG emissions reductions. The plan also contains information on who is to be affected by established policies, how these policies are to be implemented, and the cost involved with implementation, as well as monitoring responsibilities to ensure success. Monitoring and implementation are an ongoing process; therefore, the steps specified in the PolyCAP identify future actions in order to ensure progress and the desired outcome.

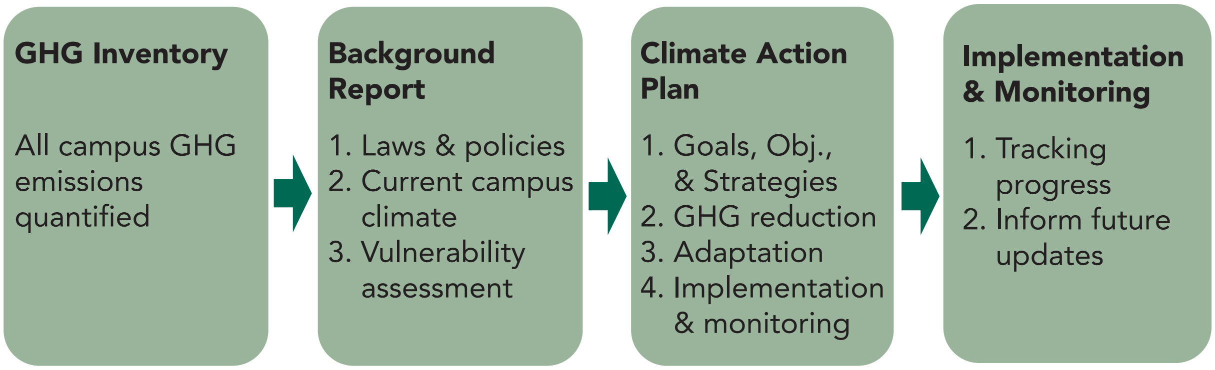


Figure 1.1 Steps of the Climate Action Plan Process

Methods

Operating under state and CSU regulations, each sector has defined goals, objectives, and strategies to achieve Cal Poly's target of 80% below 1990 levels by 2040 and furthers this goal to become a Net Zero campus by 2050. Based on the research from the background report, each sector includes strategies best suited for the University. For each strategy, a department has been identified to lead the implementation and monitoring of the strategy.

Outreach Summary

During the 2015 Fall Quarter, the PolyCAP team participated in outreach events focused on raising awareness and gathering the community's opinions on climate change. The first of two outreach events were in partnership with Cal Poly's Master Plan team and were held in the atrium of Kennedy Library and San Luis Obispo County Library. The outreach event included posters asking, "Cal Poly is taking climate action, what can we do to reduce greenhouse gases and adapt to climate change?" Attendees were asked to share their ideas by writing down their views and placing a post-it note on the poster. These events included participation from Cal Poly students, faculty, and staff, as well as the local San Luis Obispo community. In the second event of the Fall Quarter, the PolyCAP team set up in the University Union Plaza with campus maps and Polly the Polar Bear. While displaying a map of Cal Poly's campus, the PolyCAP team asked participants the following questions: What are your favorite and least favorite parts of campus? Where do you spend time on campus outside of class? How do you get to campus? Where do you enter campus? This event concentrated on identifying those areas of campus most valuable and highly utilized by the campus community as well as identifying areas that need improvement.

As a continuation of the PolyCAP development process, the PolyCAP team gathered input from the campus community to assure support for the plan and that it meets campus needs. The goal of the February 3rd outreach event was to obtain input on a specific list of strategies being considered for the PolyCAP. The event was held simultaneously at Dexter Lawn, the University Union, and Campus Market. At each location, there were posters displaying proposed strategies and a survey with more in depth questions on sector strategies. To draw people to the booths to participate, a prize raffle was advertised and Polly the Polar Bear made an appearance at each location. For the poster activity, attendees were given five stickers and asked to place them on strategies they liked or supported the most. Additionally, participants were asked to fill out a survey asking more detailed questions regarding potential strategies. Participants who took the survey were entered into the raffle prize drawing. Approximately 530 participated in the sticker activity, and over 300 people responded to the survey. In an analysis of the data, the two most popular strategies from the poster were for extending bus service hours and placing community gardens on campus. From the analysis of the posters, sectors were able to gage how supportive the campus community was of their strategies. However, in conducting outreach on campus, the PolyCAP team learned that a large majority of students are uninformed regarding how the campus functions and the climate strategies Cal Poly is already implementing.

In addition to the PolyCAP team's large outreach events, each sector team spoke with various individuals and departments relevant to their proposed strategies for further research and information. Additionally, members of the PolyCAP team also attended the Cal Poly Green Campus Program Stakeholder Meeting. The results from our outreach event and information from smaller meetings are summarized by each sector team in their section.

Introduction to Sectors

The CRP 410/411 class was divided into eight sectors, each focusing on a different aspect of campus: Buildings, Agriculture, Transportation, Water, Solid Waste, Campus Life, Renewable Energy, and Public-Private Partnerships. Each sector team created the goals, objectives, and strategies included in the PolyCAP to reduce GHG emissions or adapt to climate impacts. Cost analysis, length of implementation, GHG quantification, and co-benefits are identified for every strategy. Co-benefits are different aspects of the University that are positively impacted as a side effect of the reduction in GHG emissions. These include educational opportunities, public health and safety, campus climate, mobility, finances, and environmental benefits. Sector overlap is also addressed due to the overarching nature of the PolyCAP.

Buildings Sector Summary

The buildings sector is responsible for addressing the components that involve operating and planning for facilities on campus, including energy efficiency, water usage, and ventilation systems. The primary goal is to identify and provide policies and programs to help reduce GHG emissions throughout campus, focusing on identifying the least efficient buildings and determining ways to improve their performance. In addition, the Buildings sector recognizes Leadership in Energy and Environmental Design (LEED) and other successful climate-friendly practices on campus and strives to find ways to implement them campus-wide.

Agriculture Sector Summary

The agricultural sector focuses on strategies that reduce GHG emissions on campus by focusing on sustainable rangeland management, enhancing digital tracking systems for both animals and fertilizers, preparing the agricultural departments for climate adaptation, and installing an anaerobic digester. By modernizing agricultural practices and adapting to climate change, Cal Poly can maintain its high-quality agricultural education components.

Transportation Sector Summary

The transportation sector accounts for over half of the GHG emissions associated with campus. Most of the GHG emissions results from commute behavior by faculty, staff, and students. A disproportionate number of commuters do so alone. The sector is composed of driving, walking, biking, and public transportation.

Water Sector Summary

The water sector includes both GHG emissions and adaptation measures related to water usage on campus. GHGs are emitted via the extraction, transport, and treatment of water used on campus. In addition, the water sector focuses on adapting to climate change influenced changes to weather and rainfall patterns, which increase the likelihood of drought and flooding.

Solid Waste Sector Summary

The solid waste sector pertains to the production and disposal of waste on campus. The primary method of disposal of solid waste that the PolyCAP addresses are landfills, recycling, and composting. The strategies focus on reducing trash sent to landfills by eliminating or diverting the garbage to alternative disposal systems.

Campus Life Sector Summary

The campus life sector addresses of how behavior on campus contributes to GHG emissions and climate change adaptation. Specifically, this sector focuses on reducing GHG emissions and climate change adaptation measures associated with University Housing, recreation, dining, and health.

Renewable Energy Sector Summary

The renewable energy sector reduces GHG emissions in collaboration with other sectors such as Buildings. In addition to strategies that utilize renewable energy sources, such as wind and solar, the Renewable Energy sector features strategies that promote these sources and removes barriers to their implementation, keeping in mind the overarching goal of becoming a Net Zero campus.

Public Private Partnership (PPP) Sector Summary

The PPP sector plans for the campus's future developments. Cal Poly plans to provide its faculty and staff with an affordable housing option within close proximity to campus to reduce GHG emissions related to commuting. The Cal Poly Master Plan has designated the faculty and staff housing to four sites, referred to as H-8, H-9, Slack/Grand, and The Track. Of the four designated sites, Cal Poly has narrowed down the first affordable housing development to be built on the southeastern most parcel, Slack/Grand. The site's location allows for convenient access to the campus from the Grand Ave. entrance. The Slack/Grand site consists of 420 condo-style apartments, designated primarily for faculty and staff. The University does have the option to open it to students and members of the community if it is underutilized by faculty and staff.

Sectors

Buildings

Metering allows the University to understand the energy, water, and natural gas usage per building. The building sector strategies focus on reducing GHG emissions through the installation of metering to determine areas of inefficiency. Other strategies focus on reducing energy and water consumption in buildings on campus. Cal Poly has a plan to retrofit several buildings and completely rebuild others.

The CSU Chancellor White has set the goal of 80% GHG reduction by 2040. To meet those goals, future buildings on campus must meet requirements that include meeting or exceeding the new Title 24 Energy Code for all new construction or major renovations, adopting Zero Net Energy standards for all new residential buildings under LEED O+M (operations and maintenance), and pursuing LEED Gold Certifications for all housing facilities (Cal Poly FM&D, 2014). With this plan being proposed for future development, the building sector has proposed that retrofitted buildings, at minimum, meet LEED Silver and new buildings meet LEED Gold.

Many people informed the development of this chapter. Eric Veium, Cal Poly's Energy and Sustainability Analyst, provided information regarding the Utilidor on campus, the central plant, and the buildings connected to the central cooling and heating distributors. Dennis Elliot, Director of Energy, Utilities and Sustainability, shared challenges to improved efficiency (D. Elliot, personal communication, February 10, 2016). Stacey White, Cal Poly's Architecture Lecturer and Principal at Mode Architects and working on campus LEED certification, also provided feedback.

Identity	Name	GHG 2040 Reduction (MTCO2e)
BDG Goal 1	**Net Zero structures and operations**	
BDG Objective 1.1	All new and retrofitted buildings reduce annual energy demand per gross square feet (GSF) by at least 50% from that of the former building or similar type of building	
BDG Strategy 1.1.1	Require all new and retrofitted buildings to exceed Title 24 standards by 30% or meet LEED Platinum certification requirements	137
BDG Strategy 1.1.2	Orient and mass new buildings to maximize passive cooling and heating	64
BDG Strategy 1.1.3	Require all new and retrofitted buildings to use efficient electric appliances	1,383
BDG Objective 1.2	*Monitoring and energy-efficient behavior reduces energy use by 25%-50%*	
BDG Strategy 1.2.1	Implement comprehensive metering in all new and retrofitted buildings.	N/A
BDG Strategy 1.2.2	Increase and educate staff to operate and monitor buildings efficiently	N/A
BDG Strategy 1.2.3	Expand the Utilidor	N/A
BDG Strategy 1.2.4	Replace standard electrical switches with automatic sensor energy appliances (i.e. light switches, automatic computer shut-off)	N/A
BDG Strategy 1.2.5	Disable water heating for restroom faucets in all non-housing buildings	N/A
BDG Strategy 1.2.6	Require all departments to complete the Green Campus Certification.	N/A
BDG Strategy 1.2.7	Create financial mechanisms to incentivize departments to conserve energy and water and reduce waste.	N/A
BDG Objective 1.3	*Reduce 100% of emissions associated with building operations (after implementation of all other BDG strategies)*	
BDG Strategy 1.3.1	Require all new and retrofitted buildings to include rooftop solar panels with the largest feasible array	RE Sector
BDG Strategy 1.3.2	Require all buildings to offset emissions from natural gas consumption	8,554
BDG Strategy 1.3.3	Produce enough energy to meet remaining demand from buildings not slated for replacement or retrofit	RE Sector
BDG Goal 2	**Structures that withstand or are easily adapted to the impacts of climate change**	
BDG Objective 2.1	*Reduce the impact of heat waves/temperature increase on existing cooling/ventilation systems by 2035*	
BDG Strategy 2.1.1	Replace existing building windows with double-glazed and low-emissivity coating (or similar) operable windows to reduce amount of hot/cool air loss	29
BDG Strategy 2.1.2	Prioritize envelope improvements and energy efficiency in building renovations. Add air conditioning where critically needed and provide central plant chilled water where possible.	

Outreach:

As part of doing outreach for the Climate Action Plan, the PolyCAP team participated in outreach events throughout campus, met with staff, and put together informal surveys to gather individual data in order to gather input and assess support for building sector strategies. For example, two potential policies were presented during outreach events with the aim of gathering feedback. The proposed strategies set a threshold of energy usage above which departments would be penalized and incorporated Net Zero standards into university structures. During the outreach activity, 356 students in support for both strategies. Students were interested with both approaches because they believed that making departments responsible for energy and water use would make students and departments more aware of individual use. Implementing a Net Zero approach at Cal Poly was viewed as moving campus toward being more sustainable. The PolyCAP team decided to move forward with both strategies by developing policies to implement each, conducting a fiscal analysis, and predicting how much GHG emissions can be reduced when implementing each strategy.

Strategies

BDG Goal 1. Net Zero structures and operations

A Net Zero structure is a building that produces as much energy as it consumes. For Cal Poly, this means the campus as a whole must produce as much energy as structures and operations consume, whether that energy is generated on each building or off site. The campus will increase energy efficiency through changes in behavior and design, as well as build the necessary infrastructure to produce renewable energy onsite.

BDG Objective 1.1. All new and retrofitted buildings reduce annual energy demand per gross square feet (GSF) by at least 50% from that of the former building or similar type of building

Rather than adopting building design standards as a strategy, Cal Poly can adopt whole-building energy performance targets for all campus buildings. Targets are based on those developed by the University of California Institute for Energy and Environment (UCIEE), a leader in campus energy efficiency. The target is 50% below baseline annual electricity and 100% below baseline annual thermal use per GSF (UCIEE, 2014). Using performance-based targets allows Cal Poly to use the best available technology, as opposed to solely using green building standards such as LEED. Although LEED can be used as guidelines to meet this objective, it is not necessarily sufficient to meet the targets of the PolyCAP. Performance targets do not pose any limitations on the design by which efficiency is achieved.

BDG Strategy 1.1.1. Require all new and retrofitted buildings to exceed Title 24 standards by 30% or meet LEED Platinum certification requirements

Phasing: Mid to Long
Sector Overlap: PPP
Co-Benefits: Environmental, Financial

Depending on which standards are more aggressive in the year of replacement or retrofitting, buildings will either exceed Title 24 by 30% or meet LEED Platinum standards. Implementing the design features required by Title 24 or LEED will ensure substantial reductions in energy use. Combined with improved monitoring and behavior addressed in Objective 1.2, new and retrofitted buildings will exceed Objective 1.1.

BDG Strategy 1.1.2. Orient and mass new buildings to maximize passive cooling and heating

Phasing: Mid to Long
Sector Overlap: PPP
Co-Benefits: Environmental, Financial

Orientation of a building such that it receives the most energy from the sun reduces the need for auxiliary heating and cooling. With careful orientation, buildings can increase solar access to panels for solar photovoltaics and hot water. The Passive House Standards succeed in delivering highly energy-efficient buildings, and can be used for both new and retrofitted buildings (James, 2015, p. 76). Depending on availability of funding, all new buildings are to fulfill these requirements in the near-term. The energy savings are expected to be about 50% (Fosdick, 2012).

BDG Strategy 1.1.3. Require all new and retrofitted buildings to use efficient electric appliances

Phasing: Mid to Long
Sector Overlap: PPP
Co-Benefits: Environmental, Financial

In order for the campus to achieve Net Zero operations, all gas appliances must eventually be replaced by electric appliances. Electric appliances can use energy produced from renewable sources, which eliminates dependence on fossil fuels. Since it is not feasible to replace most gas appliances in buildings that are not planned to be replaced or retrofitted before 2040, offsets are necessary to meet reduction targets. However, this strategy also applies to new and retrofitted buildings after 2040, ensuring future independence from fossil fuels.

BDG Objective 1.2. Monitoring and energy-efficient behavior will reduce energy use by 25%-50%.

To meet GHG reduction targets, energy efficiency measures cannot be limited to the design features of new and retrofitted buildings. Monitoring and behavioral changes are also needed to meet GHG reduction targets, including those slated for replacement or retrofitting.

BDG Strategy 1.2.1. Implement comprehensive metering in all new and retrofitted buildings.

Phasing: Near to Mid
Sector Overlap: Campus Life, Water, PPP, Renewable Energy
Co-Benefits: Financial

Comprehensive metering tracks both water and energy, which is critical for monitoring the effectiveness of other strategies within the PolyCAP. Older buildings either lack meters or contain faulty meters. This strategy requires all new and retrofitted buildings to include water, electrical, and natural gas meters connected to a monitoring network. Phasing in meter installation depends on the feasibility of installation and the schedule of replacement or retrofitting of existing buildings. Several factors are to be considered before installing new meters in existing buildings, including hazardous materials, ease of installation, and type of meter (quality and accuracy).

BDG Strategy 1.2.2. Increase and educate staff to operate and monitor buildings efficiently

Phasing: Near
Sector Overlap: Campus Life, Water, PPP, Renewable Energy
Co-Benefits: Financial

More staff and training are necessary to adequately track energy use of each building. Presently, even the LEED certified buildings with functioning meters are not operated as efficiently as possible. Cal Poly FM&D currently produces monthly reports of energy and water use. Therm use is only available for buildings that use chilled or hot water. Due to the lack of staffing and funding, meter installation and maintenance is a low priority compared to outages and other critical operations (D. Elliot, personal communication, November 4, 2015). Furthermore, all existing staff are not adequately trained to collect and interpret meter data.

BDG Strategy 1.2.3. Expand the Utilidor

Phasing: Mid
Sector Overlap: Campus Life
Co-Benefits: Financial

The Utilidor is an underground system of pipes that efficiently circulate central plant hot and chilled water around the campus core. Most buildings are connected to hot water and more than 20 buildings are connected to chilled water. Connecting all existing buildings to chilled water is not feasible, but FM&D intends to connect all new buildings. Expanding and running the Utilidor at maximum efficiency will increase energy savings. Cal Poly plans to expand the capacity of the Utilidor, which requires a master plan, feasibility study, and approximately $10 million for new equipment. The construction time needed to expand the Utilidor less than five years, but it will be five to ten years until the necessary funding is obtained. Phasing in the Utilidor expansion depends on the relative prioritization of energy efficiency in the University budget.

BDG Strategy 1.2.4 Replace standard electrical switches with automatic sensor energy appliances (i.e. light switches, automatic computer shut-off)

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Environmental, Financial

Automatic sensors ensure that appliances are only activated when they are being used. A number of labs, restrooms, classrooms, etc. have already replaced standard switches with automatic sensors, but many still have manual switches. New and retrofitted buildings will include automatic sensor appliances, but buildings not slated for replacement or retrofitting need to replace as many manual switches as possible. According to a project at the University of Illinois at Urbana-Champaign, installing more than 560 occupancy sensors reduces electricity use by more than 250,000 kWh, which results in "an annual GHG reduction of 120,000 lbs of CO2 emissions" (Hubbell Incorporated, *n.d.*, p. 4).

BDG Strategy 1.2.5. Disable water heating for restroom faucets in all non-housing buildings

Water heating is currently dependent on natural gas, and is not necessary for restroom faucets in academic, administrative, and dining buildings. Disabling the water heating is feasible within a year, because it does not require new infrastructure.

> ***Phasing:*** Near
> ***Sector Overlap:*** Campus Life
> ***Co-Benefits:*** Environmental, Financial

BDG Strategy 1.2.6. Require all departments to complete the Green Campus Certification

The Sustainability Mentor Program is a voluntary program providing guidelines for departments, buildings, divisions, or colleges to implement and reinforce sustainable practices in day-to-day operations and planning. The guidelines address administration, energy conservation, water conservation, recycling and waste reduction, purchasing, and transportation (Green Campus Program, 2013). This strategy requires all departments participate in this program. Many of the required measures, such as behavioral changes and the reduction of paper use, are low to no cost. The program is expected to reduce the operating costs of participating departments. The assessment of effectiveness of this strategy relies on the implementation of metering on all departmental buildings.

> ***Phasing:*** Near
> ***Sector Overlap:*** Campus Life, Water, Solid Waste
> ***Co-Benefits:*** Environmental, Financial, Educational

BDG Strategy 1.2.7. Create financial mechanisms to incentivize departments to conserve energy and water and reduce waste.

FM&D currently is responsible for paying utility bills of all campus departments, so departments are unaware of their energy usage. This strategy establishes a threshold based on the past energy use of each department, and apply a reduction factor. If a department exceeds this threshold, the individual department is responsible for paying that overage. Strategy 1.1.1.1 – comprehensive metering -- is necessary for the successful implementation of this strategy. Overage charges are supported by the Sustainability Mentor Program (Strategy 1.4.1.), which provides strategies and guidelines to reduce energy use.

> ***Phasing:*** Near
> ***Sector Overlap:*** Renewable Energy, Water, Campus Life
> ***Co-Benefits:*** Financial, Educational

BDG Objective 1.3. Reduce 100% of emissions associated with building operations (after implementation of all other BDG strategies)

The strategies described above are not sufficient to reach Net Zero operations. On-site energy production and carbon sequestration are needed to reduce 100% of GHG emissions. If on-campus options are not sufficient, local or regional options can be pursued.

BDG Strategy 1.3.1. Require all new and retrofitted buildings to include rooftop solar panels with the largest feasible array

The strategies described above are not sufficient to reach Net Zero operations. New buildings can, however, offset the emissions from any remaining energy use. Options for on-campus offsets include renewable energy production

> ***Phasing:*** Mid to Long
> ***Sector Overlap:*** Renewable Energy, Campus Life
> ***Co-Benefits:*** Financial, Educational

or carbon sequestration. If on-campus options are not sufficient, local or regional offsets will be purchased.

BDG Strategy 1.3.2 Require all buildings to offset emissions from natural gas consumption

The campus will need to plant trees and purchase carbon credits to offset emissions from natural gas until an alternative is available.

Phasing: Mid to Long
Sector Overlap: Renewable Energy, Campus Life
Co-Benefits: Financial, Educational

BDG Strategy 1.3.3 Produce enough energy to meet remaining demand from buildings not slated for replacement or retrofit

See Renewable Energy section.

BDG Goal 2. Structures that withstand or can easily adapt to the impacts of climate change

Equip buildings and operations to cope with impending heat waves, increased flood risk, wildfire, and increased average temperatures.

BDG Objective 2.1. Reduce the impact of heat waves/temperature increase on existing cooling/ventilation systems by 2035

An increase in average temperatures and frequency of heat waves increases demand for cooling and ventilation systems. Many academic buildings use outside air ventilation, but these systems are not adequate for maintaining a comfortable temperature or protecting lab equipment from heat damage. Nonacademic buildings, including residential and dining buildings, are currently equipped with cooling and ventilation systems that may not be adequate. Some buildings need to improve their existing ventilation and/or cooling systems, whereas others need completely new systems. New buildings and those scheduled to be retrofitted in the near future will meet standards defined in BDG Objectives 1.2 and 1.3 ensuring efficient, effective, and durable cooling and ventilation systems. However, it is not feasible to retrofit all existing buildings in the near future, so smaller but impactful improvements are necessary to meet time-sensitive needs.

BDG Strategy 2.1.1 Replace existing building windows with double-glazed and low-emissivity coating (or similar) operable windows to reduce amount of hot/cool air loss

All new and retrofitted buildings will include double-glazed and low-emissivity coating in order to reduce hot/cool air loss. During extreme heat days, which are expected to be more frequent and intense, it is crucial for Cal Poly to ensure comfortable indoor temperatures.

Phasing: Mid to Long
Sector Overlap: PPP
Co-Benefits: Financial

BDG Strategy 2.1.2 Prioritize envelope improvements and energy efficiency in building renovations. Add air conditioning where critically needed and provide via central plant chilled water where possible.

Building retrofit in some cases requires renovation of building envelope to support energy efficiency measures. Air conditioning will only be added in cases where interior conditions are projected to pose a threat to inhabitants.

Phasing: Mid to Long
Sector Overlap: Campus Life
Co-Benefits: Financial

Agriculture

At Cal Poly, agricultural activity is housed in the College of Agriculture, Food, and Environmental Sciences (CAFES) and operated by the Agricultural Operations Department (Ag. Ops.). Several practices within campus agricultural activities influence GHG emissions, including enteric fermentation, fertilizer application, composting operations, and waste lagoon management. Agriculture's two largest emitters are enteric fermentation and waste lagoon management, accounting for 77% and 17%, respectively (FM&D, 2015). Enteric fermentation is the process in which ruminants (cows, sheep, and goats) digest food. The GHG impact of this process is the production of methane through biological functions.

Agriculture is vulnerable to the effects of a changing climate. An increase in average temperature has detrimental effects on livestock health, including increased instances of disease, and reduction in reproductive behavior. Increased drought may create shortages in agricultural water use and livestock food sources, and subsequently, a loss of educational opportunities within CAFES.

Currently, Ag. Ops. and CAFES are employing strategic agricultural practices to promote sustainable operations. These practices include reducing the grazing cattle herd size, reducing the agricultural water use by 25% (A. Lazanoff, personal communication, February 19, 2016), and installing updated irrigation infrastructure for the crop fields (Cal Poly, 2015).

The PolyCAP, Ag. Ops., and CAFES aim to maintain principles of educational value, as well as moving toward in new operational methods. The PolyCAP strategies reduce GHGs and facilitate adaptation for the horticulture, dairy, and livestock operations on campus.

Identity	Name	GHG 2040 Reduction (MTCO2e)
AG Goal 1	**A technologically innovative Ag. Ops. that produces minimal GHG emissions**	
AG Objective 1.1	*Utilize the animal waste to reduce GHG emissions and generate energy*	
AG Strategy 1.1.1	Assess anaerobic digester feasibility	N/A
AG Strategy 1.1.2	Implement an anaerobic digester	334
AG Objective 1.2	*Make fertilizer data accessible across CAFES and Ag. Ops.*	
AG Strategy 1.2.1	Track fertilizer in all programs	N/A
AG Strategy 1.2.2	Share the data from fertilizer use tracking systems	N/A
AG Objective 1.3	*Reduce GHG emissions associated with livestock*	
AG Strategy 1.3.1	Utilize sequestration via sustainable range management	2,428
AG Strategy 1.3.2	Track each individual animal	N/A
AG Strategy 1.3.3	1.3.3 Change livestock diets	29
AG Goal 2	**Campus agricultural operations adapted for climate change**	
AG Objective 2.1	*Maintain an adequate population of livestock for educational and operational purposes*	
AG Strategy 2.1.1	Develop a CAFES/Animal Science/Agriculture Operations livestock adaptation plan	N/A
AG Strategy 2.1.2	Invest in livestock resilient to climate change	18

Outreach

The Agriculture PolyCAP sector met with multiple staff and faculty at Cal Poly to research and learn about the current agricultural practices and their goals for the future. Below is a summary of the information and meetings with: Aaron Lazanoff, Dennis Elliot, Scott Steinmaus, Johnny Rosecrans, Beth Reynolds, Eric Veium, and Kevin Piper. In addition to the sector's staff meetings, other outreach efforts for the PolyCAP gained complementary data relevant to this particular sector.

Aaron Lazanoff disclosed that the campus currently has a computer tracking system for beef cattle called CattleMax. CattleMax includes relevant information pertaining to individual cattle, such as age, tag number, and expected due dates, amongst other information. Lazanoff indicated that the system is available University-wide, as well as accessible via USDA's website under Process Verified Program. He also explained that dietary changes for beef cattle is unrealistic as they graze, changes in dairy cow diets are a possibility since dairy cows are fed in confinement and their eating behaviors are regulated.

Scott Steinmaus and Johnny Rosecrans explained the fertilizer tracking system used by the Crops Unit at Cal Poly. Both fertilizer and pesticides are tracked and follow strict state and federal regulations. Some of the fertilizer characteristics that are tracked include type, soil type, water use, and crop uptake. Johnny provided the technical information on the current fertilizer system, and detailed information on how yearly fertilizer programs are developed.

Beth Reynolds tracks sheep and goats. She was highly supportive of a student, or part-time position be created to collect data from each of the livestock areas and then compiled in a centralized location. Beth communicated that the best time to collect this data would be in June, when an official count is already taken.

Eric Veium suggested the concept of an anaerobic digester to implement in campus agricultural operations and help reduce GHGs. The anaerobic digester idea originated from a 2008 Chevron feasibility study. Dennis Elliot offered information regarding necessary phasing and timeline considerations, as well as providing design options.

The discussion with Kevin Piper included examination of the idea of requiring a minimum amount of animals to ensure the quality of educational opportunities within CAFES. In addition, maintaining a minimum agricultural production is crucial; for instance, the dairy requires a certain amount of animals to fill a truck of milk. However, there were stipulations about committing to a specific animal threshold. This may limit the potential to downsize herd sizes in later years in case of further drought conditions.

In the general PolyCAP outreach events, students were asked to indicate whether or not they agreed that agriculture was a valuable part of Cal Poly. Out of 310 respondents, 244 (78%) either agreed or strongly agreed, 60 (20%) were neutral, and 6 (2%) disagreed or strongly disagreed about agriculture's value on campus. 20% of the respondents belonged to CAFES, which closely reflects the distribution of students at Cal Poly (19.69% CAFES). Of the potential PolyCAP strategies presented during the event, the anaerobic digester was the fifth most popular, receiving 292 of the 2,610 stickers, roughly 11%.

Strategies

AG Goal 1. A technologically innovative Ag. Ops. that produces minimal GHG emissions

Ag. Ops. contributes towards a Net Zero campus by updating technology, using animal and consumer waste to produce energy, and utilizing efficient tracking systems for fertilizer use and livestock.

AG Objective 1.1. Utilize the animal waste to reduce GHG emissions and generate energy

Currently, the dairy waste lagoons represent 17% of the total emissions from agriculture. Reducing the emissions associated with animal waste contributes to sustainability on campus by offsetting emissions with the creation of usable energy.

AG Strategy 1.1.1. Assess anaerobic digester feasibility

Phasing: Near
Sector Overlap: N/A
Co-Benefits: N/A

Cal Poly identified a report from 2009 using the Biogas Energy System as an appropriate fit to campus (B&N Enterprises, 2009). The Biogas Energy System is an anaerobic digester that sends biogas to a co-generation plant to generate electricity and heat (Biogas Energy Systems, 2015). A feasibility report for the anaerobic digester needs to study the following components:

- System choice and location
- Design, construction, operation, and maintenance costs
- Transportation of waste and produced heat and electricity
- Waste disposal

AG Strategy 1.1.2. Implement an anaerobic digester

Phasing: Mid
Sector Overlap: Solid Waste, Renewable Energy
Co-Benefits: Campus Climate, Environmental, Educational, Financial

Upon determining the feasibility of the anaerobic digester, the system can be constructed and utilized. This process takes longer than ten years with a medium cost to implement. This process is expensive due to the required infrastructure in both the agricultural and electrical systems. Operation of the digester is a joint effort between Ag. Ops., Campus Dining, and FM&D to collect the minimum amount of waste needed for system operation. Resulting effluent produced as a byproduct from the process can be used as fertilizer. The anaerobic digester reduces nearly all waste lagoon-related emissions.

AG Objective 1.2. Make fertilizer data accessible across CAFES and Ag. Ops.

Agricultural crop processes are responsible for emitting GHGs through fertilizer usage and certain farming techniques. Managing fertilizer usage and implementing strategic farming practices allows the Cal Poly campus to further adapt to climate change.

AG Strategy 1.2.1. Track fertilizer in all programs

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational, Public Health & Safety, Community Cohesion

While most of Cal Poly's crop programs are extremely diligent in tracking fertilizer type and use, not all areas are tracked as well as others. The student farm in particular does not currently track fertilizer to Ag. Ops. and

CAFES standards. All areas that do not currently track fertilizer usage (application, type, etc.) need to implement a system to do so. It is a state requirement to keep track of fertilizer usage on the larger operations on campus, especially as it pertains to water quality. Smaller operations on campus that are not held to this standard should do so as well, due to potential aggregate effects.

Currently, a computer log tracking orchard fertilizer use is located within the Horticulture Department. (Rosencrans, personal communication, February 22, 2016). This log tracks the type of fertilizer, soil type, volume of application, and water use, among other factors. This system is a good example to follow, but each operation is free to determine the components of their own specific tracking system.

AG Strategy 1.2.2. Share the data from fertilizer use tracking systems

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational, Public Health & Safety, Campus Climate

A centralized location for fertilizer application data unifies disaggregate data from the different agricultural units on campus. There are many units on campus, such as the orchards that track and compile fertilizer data to a high degree of specificity on a regular basis. When combined with new data from 1.2.1, an opportunity exists to create a comprehensive, searchable database. This would benefit Cal Poly students, faculty, and staff in various research capacities, as well as updates of the Cal PolyCAP. This database should be shared in an accessible campus location. This database does not directly reduce GHG emissions, but it may identify areas in which reductions can be achieved in the future.

AG Objective 1.3. Reduce GHG emissions associated with livestock

Ag. Ops and CAFES reduce GHG emissions by utilizing innovative sequestration techniques, continuing sustainable range management practices, and methane-reducing ruminant diets.

AG Strategy 1.3.1. Utilize sequestration via sustainable range management

Phasing: Near
Sector Overlap: Solid Waste, Water
Co-Benefits: Educational, Environmental

Cal Poly can analyze soil samples to find strategic information including: soil type, bulk density, minimum and maximum stocking rate, texture, pH, and ground cover. This information allows Cal Poly to tailor its range management practices toward additional sequestration. Cal Poly can also conduct analyses on the performance of different range management practices to identify those most successful for carbon sequestration. Cal Poly's biggest opportunity to sequester carbon is by continuing sustainable range management practices. Sustainable range management has been shown to sequester carbon by ensuring that grasslands are not subject to overgrazing. This also results in a much higher water retention rate in the grasslands. In this process, it is important to quantify the impacts of sustainable range management, ensuring maximum efficiency. Sustainable range management systems sequester carbon dioxide emissions in the surrounding atmosphere, in the process offsetting GHG emissions from other emissions sources on campus. The exact reduction in emissions would be based on the specific type and size of sustainable range management program implemented as well as the location of the management site.

AG Strategy 1.3.2. Track each individual animal

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational, Public Health & Safety, Campus Climate, Community Cohesion

Cal Poly uses a computer program called CattleMax to record herd inventories. This program specifically keeps track of each individual head of cattle's age, birth date, weight, tag number, expected due date, sire, dam, treatments, and other relevant information pertaining to a specific animal (Nelson, 2010) and is currently located on a cloud computer system within the Beef Unit of the Animal Science Department. This information can be utilized for GHG emission calculations, making data readily available for university-wide research and data analysis. Similar to AG Strategy 1.2.1, the cattle inventory is made available in the library computer labs and the Animal Science Department lab computers, as well as published in print and/or online at least once a year. In addition to the current cattle inventory, this practice is applied to the other units in the Animal Science Department on campus, including goats, sheep, swine, and dairy cows. The management or preparation of the cattle system would not change from the current housing in the Beef Unit of the Animal Science Department, however the additional livestock systems are to be housed in their corresponding units within the Animal Science Department. This inventory does not inherently reduce GHG emissions but rather collects and shares data on the campus's livestock population.

AG Strategy 1.3.3. Change livestock diets

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational

Ruminant animals release methane based largely on diet. The Dairy Science Department can research which dairy cow diets cause the lowest GHG emissions levels. Based on information from the USDA, livestock dietary changes can decrease emissions by 5%-20% with an increase in fat in the diet (Cole et al., 2012). If utilized, this strategy works to reduced GHGs from dairy cows by 5%-20% due to a dietary change. This strategy is near term in scope as it does not take long for Ag. Ops. to research and implement efficient diets for the livestock at Cal Poly. The potential limiting factor is cost.

AG Goal 2. Campus agricultural operations adapted for climate change

Campus adaptation measures, such as maintaining an adequate amount of livestock for educational purposes, can benefit Cal Poly in its endeavors to incorporate climate awareness in its existing behaviors and practices.

AG Objective 2.1. Maintain an adequate population of livestock for educational and operational purposes

Livestock is a critical component of the agricultural educational programs at Cal Poly that must be maintained despite the changing climate. The educational benefits provided by livestock to students is not only important for existing curricula and programs, but also for livestock management in a changing climate. When Strategy 1.1.2 is implemented, it requires a minimum number of dairy cattle and other livestock on campus to effectively operate the anaerobic digester.

AG Strategy 2.1.1. Develop a CAFES/Animal Science/ Agriculture Operations livestock adaptation plan

In response to the drought, in 2010, Cal Poly sold all of its grazing cattle. In the long-term, this is not the best adaptation strategy because it creates a loss of

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational, Campus Climate

AG Strategy 2.1.1. Develop a CAFES/Animal Science/Agriculture Operations livestock adaptation plan

In response to the drought, in 2010, Cal Poly sold all of its grazing cattle. In the long-term, this is not the best adaptation strategy because it creates a loss of educational opportunities. However, the reductions were necessary for environmental and cost purposes. CAFES and associated departments should develop a plan to preserve and maximize educational opportunities and efficiency. This would include analyzing minimum populations needed for all on-campus livestock, considering their cost and campus value. This plan would also identify the minimums required for all academic livestock programs and the proposed anaerobic digester to remain in operation so that the programs continue as the climate changes.

AG Strategy 2.1.2. Invest in livestock resilient to climate change

Phasing: Mid
Sector Overlap: Water
Co-Benefits: Educational

Some livestock species are more adaptable to climate change than others and can persist and overcome drought-related issues such as extreme heat, less water availability, and less grass availability. Other species of livestock, such as the Criollo cow, are better adapted to arid conditions through centuries of natural selection, tracing back to Christopher Columbus (Carswell, 2014). This strategy allows livestock to thrive in the changing San Luis Obispo climate and use fewer resources, while not severely decreasing the output of the Beef Unit. This option creates a new educational opportunity for Cal Poly to be on the forefront of cattle climate adaptation strategies.

Transportation

Transportation currently accounts for over half of the GHG emissions at Cal Poly. This sector focuses on automobiles, public transportation, bicycles, and walking. The major contributor to GHG emissions in this sector is automobile commute. Twenty-four percent of students commute by this method and 68% of faculty and staff. This makes for a total of 38% of commuters driving alone to campus.

Many students walk to campus. Walking accounts for 41% of students' commutes. Eight percent (8%) of faculty and 19% of staff use this mode to commute to campus. Ten percent (10%) of students commute by public transit and around 5% of staff and faculty. This includes both SLO Transit and SLO RTA. According to the 2015 Cal Poly Transportation Survey, the average commute length to campus is 17.4 vehicle miles traveled (VMT) per day per commuter.

For the majority of campus constituencies, this modal choice is largely dictated by how far one lives from campus. For example, students who commute by car and staff live farther from campus than faculty. While some may find this trend for students counterintuitive since many students do in-fact live close to campus, in actuality the second largest share of both students and faculty and staff live greater than 10 miles from campus. This aspect of student residential behavior over geography is worth consideration in campus housing and transportation policies.

In terms of built environment assets, there are currently bike routes that reach the campus, including the Railroad Safety Trail, that enable students to commute on off-street (Class-I) bikeways. There are 4 SLO Transit bus routes that reach campus every day, as well as RTA routes from North County (Paso Robles) and South

Identity	Name	GHG 2040 Reduction (MTCO2e)
TRN Goal 1	**Low GHG Emissions Commute**	
TRN Objective 1.1	*Adjust parking permit policy to reduce the number of cars on campus*	
TRN Strategy 1.1.1	Increase the number of housing units for students on campus (CL Objective 1.3) and eliminate residential parking permits for freshman and sophomores living on campus	CL Sector
TRN Strategy 1.1.2	Create a 1.5-mile radius from the campus core in which students cannot purchase general parking permits	25
TRN Strategy 1.1.3	Establish a climate impact fee for each parking permit issued	2,010
TRN Strategy 1.1.4	Create a comprehensive carpool program for students, faculty and staff	By
TRN Objective 1.2	*Increase public transportation options to campus*	
TRN Strategy 1.2.1	Increase frequency and reliability of bus service	2,300
TRN Objective 1.3	*Create a comprehensive marketing, education and incentives program that promotes and incentivizes the biking, walking and transit*	
TRN Strategy 1.3.1	Educate students, faculty and staff about sustainable transit options	3,075
TRN Strategy 1.3.2	Offer bike vouchers/discounts for students, faculty and staff living off-campus who opt to commute to campus via bicycle	1,159
TRN Strategy 1.3.3	Establish a faculty and staff employee parking incentive program	1,302
TRN Goal 2	**Low Emissions on Campus**	
TRN Objective 2.1	*Decrease the use of campus owned vehicles*	
TRN Strategy 2.1.1	Phase out the existing vehicle fleet as departments begin to rely on car share and car rental programs	400
TRN Goal 3	**Low Emissionss Long Distance Travel**	
TRN Objective 3.1	*Eliminating unnecessary long distance trips*	
TRN Strategy 3.1.1	Offer carbon offsets for long distance travel	671

County on the weekdays, 1.4 miles of which is on the campus. (Note buses make a circular route through the campus without a 'return' trip for a total of approximately 840 weekly trips based on 2015-2016 schedules. RTA does not come all the way to campus.) There are 7,700 parking spaces on campus; this is after a 1,000-space reduction for the construction of Student Housing South.

The future of this sector is one of dramatic reductions in GHG emissions. Because transportation is over half of campus GHG emissions, it requires the most reductions in the PolyCAP. The strategies to reduce GHG focus on offering incentives to encourage alternative transportation modes.

Outreach

A significant amount of feedback regarding transportation was solicited during outreach events. Based on responses from the poster activity, the extension of transit hours was the most supported transportation policy. Three hundred eighty people, primarily students, supported the extension of transit hours out of 522 total participants (73%). Other transportation strategies included on the outreach posters were the implementation of a campus bike-share program, which 206 people supported, and the expansion of the Zipcar program, which 60 people supported. In addition to large outreach events, members of the community involved with transportation at Cal Poly were contacted and provided feedback. This included the areas of campus parking policy, along with information on transit operations and ridership agreement with SLO Transit.

While these take a transportation policy focus – important to keep in mind that implementing appropriate and well-designed infrastructure on-campus is an important priority for the campus and a prerequisite for any programs aimed at encouraging increased travel via biking, walking or transit. For example, as illustrated in the images below, many campus signs and roadway markings are not consistent with the State of California's Manual on Uniform Traffic Control Devices (MUTCD) could result in creating unsafe environments for campus traveler. Careful attention to and funding of active transportation infrastructure is paramount for the success of the strategies below.

Strategies

TRN Goal 1. Low GHG Emissions Commute

The University should change the way parking permit are valued and issued to encourage students, faculty, and staff not to bring their vehicles to campus. These policies focus on reducing Commuter Travel GHG emissions—the largest individual source of MTC02e in the GHG Inventory.

TRN Objective 1.1. Adjust parking permit policy to reduce the number of cars on campus

With the new residential development happening on campus, the University must rethink how it processes and enforces parking permits and pricing. This might include: 1) considering time of day or location based peak pricing; 2) unbundling monthly permits to allow for daily or hourly payment vs. monthly permits; 3) the use of a climate impact fee added to permits to account for the full cost of providing parking spaces (See Strategy 1.1.3). Taking advantage of the new development occurring, and considering the opportunity cost for campus land and financial resources, creates an opportunity to revise and create more climate friendly parking and permitting system.

TRN Strategy 1.1.1. Increase the number of housing units for students on campus (CL Objective 1.3) and eliminate residential parking permits for freshman and sophomores living on campus

> ***Phasing:*** Near
> ***Sector Overlap:*** Campus Life, PPP
> ***Co-Benefits:*** Educational, Public Health/Safety, Campus Climate, Financial, Environmental

By increasing the number of housing units on campus, the university can begin to decrease the percentage of students who live in off-campus housing and subsequently commute to the university using personal single occupancy vehicles. After Student Housing South is completed in 2018, the university will house over 40% of all undergraduate students. By eliminating residential parking permits for freshman and sophomores living on campus, the university can promote transportation alternatives such as biking, walking and public transportation for students getting around San Luis Obispo.

Modeling sustainable behavior and supporting a vibrant campus environment are an important part of the Cal Poly Draft Master Plan Update efforts. Not allowing first and second year students to have vehicles on campus reframes the parking paradigm. Campus car bans are already implemented at a number of universities across the nation and was mentioned in the 2001 Master Plan.

The policy should be phased in by eliminating permits for freshman in the 2017-18 academic year and be expanded to sophomore permits for the 2018-19 academic year. This phasing coincides with the completion of Student Housing South and does not impact current freshmen and sophomores who choose to live on campus. It should be reiterated that, at the same time it would be important to increase the number of activities available on campus, and invest in travel options to make sure that students remain able to access the wider community.

TRN Strategy 1.1.2. Create a 1.5-mile radius from the campus core in which students cannot purchase general parking permits

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Public Health/Safety, Financial, Environmental, Community Cohesion

Creating a radius where students are not allowed to park on campus based on distance from school availability of transit options incentivizes the use of alternative modes of transit. The majority of off-campus student housing is located within this radius, including many of the major student apartment complexes, such as Mustang Villages and Valencia, and neighborhoods where students rent houses. Despite the number of students living within this area, many are driving to school where parking is limited. Clear policy guidelines would be needed for permit eligibility and exceptions could be made for those who are disabled or have other extenuating reasons for needing a permit.

This policy would require a creative strategy of enforcement that could be accomplished by transitioning permits to a digital form--either via GPS based permit systems or engaging a mobile-phone enabled system that would track origin and destination behavior. With this policy and upgraded technology, not only could the campus explore variable pricing by residential location, it could also explore unbundling of permits to allow for more sophisticated pricing of campus parking resources. The plan could also be refined and expanded to align with changes in bus routes and optimize appropriate distances (perhaps greater than 1.5 miles).

TRN Strategy 1.1.3. Establish a campus-wide climate impact fee for each parking permit issued

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Public Health/Safety, Financial, Environmental

By adjusting parking pricing to include a climate impact charge, Cal Poly's Administration & Finance division can disincentivize driving alone to campus and fund other climate action programs. The climate impact charge is a policy that can be implemented at minimal cost to the University and takes effect almost immediately. By disincentivizing driving to and parking on campus, the primary effect of a climate impact charge is a reduction of campus GHG emissions. The climate impact charge also raises awareness for the steps that campus is taking towards climate action. As with other policies, a substantive investment in parking technology and full pricing study is recommended before commencing with this strategy.

TRN Strategy 1.1.4. Create a comprehensive carpool program for students, faculty and staff

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Public Health/Safety, Campus Climate, Mobility, Financial, Environmental, Community Cohesion

Currently, Cal Poly has a limited carpool program for faculty and staff commuters (iRideshare) and provides 'premium' parking spaces for the carpool drivers. The existing program for faculty and staff is improved and expanded to students. An enforcement strategy would need to be devised as well to ensure that the incentive to participate (premium spaces) does not result in abuse of the policy. Additional signage and road painting are required. Campus must determine the cost of new technology infrastructure and structure a different class of parking permit.

TRN Objective 1.2. Increase public transportation options to campus

Public transportation is a viable alternative to automotive travel. Currently, 8% of students, staff, and faculty use public transit to commute to campus. With this strategy, the University increases the use of public transit to campus, especially during peak morning and evening commute hours.

TRN Strategy 1.2.1. Increase the frequency and reliability of bus service

Phasing: Mid to Long
Sector Overlap: Campus Life, PPP
Co-Benefits: Educational, Public Health/Safety, Mobility, Environmental, Community Cohesion

By increasing the bus services with additional buses during peak hours (8am-10am Monday through Friday and 4pm-6pm Monday through Friday), increasing the hours during the night (until 12am on weekdays and 10pm on weekends) and increased reliability of existing services, the number of people served is predicted to rise. Routes 4, 5, and 6A/6B, all serve locations with substantive student residents, which could increase ridership; literature indicates between 5% and 15% (TCRP, 2005). As a first step Route 6A/6B could be expanded, with Routes 4 and 5 expanded based on success.

Cost estimates include operations and equipment, however, not infrastructure, which is assumed to be in place. It is possible that new buses would be needed (estimated 3-4), which would require an expense by SLO Transit and possible negotiation between Cal Poly and the City. The GHG emissions factor for buses is less than cars because buses can accommodate up to 60 people versus single occupancy cars.

TRN Objective 1.3. Create a comprehensive marketing, education and incentives program that promotes and incentivizes the biking, walking and transit

Since an increase in permit pricing is to be applied and a reduction in number of permits sold, Cal Poly must provide marketing, education and incentives for commuters to use alternative transportation. Outreach programs that educate the campus community and incentivize the use of alternative transportation are necessary in order to create a change in commuter behavior.

TRN Strategy 1.3.1. Educate students, faculty and staff about sustainable transit options

Phasing: Near
Sector Overlap: Campus Life, PPP
Co-Benefits: Educational, Public Health/Safety, Campus Climate, Mobility, Financial, Environmental, Community Cohesion

Increasing awareness of alternative transportation options is a way to encourage students to change their commute habits. Since the university already has an opportunity to communicate with incoming students during orientation, this is a cost effective means of getting the word out to the student body. The outreach can be done by WOW and SLO Days facilitators or at faculty and staff orientations and should include information about bus route information, discounts for bus and transit, carpooling groups and the car sharing options are presented in this plan. These events are part of a well-branded program, such as the Cal Poly Cool Rides program, and include personalized marketing information. Literature shows that this has a dramatic effect on travel awareness (Riggs, 2015; Riggs and Kuo, 2015). This program might be expanded in parallel with TRN Strategy 1.3.3.

TRN Strategy 1.3.2. Offer bike vouchers/discounts for students, faculty and staff living off-campus who opt to commute to campus via bicycle

Phasing: Mid
Sector Overlap: Campus Life
Co-Benefits: Educational, Public Health/Safety, Campus Climate, Mobility, Financial, Environmental

This strategy rewards students, faculty and staff for biking to campus using a bike voucher/discount program. Students, faculty and staff who choose to opt out of purchasing a parking permit on campus for the entire year would receive a $200 voucher towards the purchase of a bicycle, usable at local bicycle shops. By accepting the voucher, students, faculty and staff are precluding themselves from purchasing a quarterly or yearly pass for the duration of the academic year. To implement this program, University Police (UPD) must organize a way to distribute and track vouchers. UPD should enter into contracts with local bicycle shops so that the vouchers are usable by students. It also may be important to assess the program for students living in residence halls in the longer term and pursue companion programs supporting bike maintenance instruction and services.

TRN Strategy 1.3.3 Establish a faculty and staff employee parking incentive program

Phasing: Mid
Sector Overlap: Campus Life
Co-Benefits: Public Health/Safety, Campus Climate, Financial, Environmental

A comprehensive program of incentives is developed for faculty and staff to incentivize active commuting. Such a program taps into social or fiscal market norms, but literature indicates it should not try to accomplish both (Riggs, 2015; Heyman and Ariely, 2004). In the area of social norms this could include: a social application that allows for group connections; a commute club where campus travelers are entitled to a free cup of coffee; or a free monthly gym membership to allow for a shower before work.

Likewise, a financially based incentive could be used to receive money back for taking an alternative mode of transportation to work, as an offset to the fact that they did not use the campus parking resource. Termed parking 'cash-out,' many companies have implemented such programs to decrease single occupancy vehicle trips to their business with positive results. At Cal Poly, a pure cash-out program can be implemented during the union contract negotiation. Every employee who opts out of getting a parking pass could be paid a stipend to take an alternative mode of transportation. A stipend of $200 per employee per year is a conservative estimate.

As an alternative, the campus could use a hybridized cash-out program where commuters are entered into a daily raffle for a prize of cash or goods. Literature shows that this can have an effect equal to cash-outs since, as long as individuals are engaged, they believe they have a chance at winning (Ariely, 2008). A variation of this approach has been very successful as a part of the Stanford CAPRI program.

TRN Goal 2. Low Emissions on Campus

Three percent of Cal Poly's transportation emissions can be attributed to the campus vehicle fleet. Cal Poly can curtail its GHG emissions by addressing this issue area by adopting strategies that improve the efficiency of the fleet and reduce use of vehicles on campus. Through these strategies, Cal Poly aims to achieve Net Zero emissions related to campus-owned vehicle use.

TRN Objective 2.1. Decrease the use of campus owned vehicles

Campus emissions are a smaller portion of transportation emissions, but an area over which the University has control. Consolidating trips that staff and faculty take in campus vehicles or eliminating those vehicles all together is an effective way of cutting down on GHG emissions in this sector. Some of this may stem from making the fuel mix of the existing fleet more green or shifting to other vehicle types such as bikes, cargo bikes, and neighborhood electric vehicles (NEVs).

TRN Strategy 2.1.1. Phase out the existing vehicle fleet as departments begin to rely on car share and car rental programs

Phasing: Mid
Sector Overlap: Campus Life, PPP, Building
Co-Benefits: Campus Climate, Improve Mobility, Financial, Environmental

Under this strategy, Cal Poly relies solely on car sharing and rental cars. All campus fleet vehicles that are not specialized (e.g. police cars, tractors, electric vehicles, etc.) would be phased out. The cost of utilizing car sharing and car rental programs is comparable to the amount spent on car maintenance, storage, and gas. Studies show that car-sharing programs reduce VMT 27-33% per user per year (Lovejoy & Handy, 2013). According to the Master Vehicle Fleet List, there are currently 546 registered vehicles on campus. Out of these 546 vehicles, 396 are fueled by diesel or gas, contributing to the GHG emissions created on campus. The current car-sharing provider on campus is Zipcar and the existing car rental provider on campus is Enterprise. Zipcar provides up to 180 miles free per day, free gas, and free insurance. Zipcar has already increased the number of cars on campus from 2 cars up to 8 cars in the past 2 years.

Currently several campus departments have accounts with Zipcar. These accounts allow the departments to cover the cost of driving for anyone who registers under their account. Enterprise has an office on campus allowing for any department that needs a car for a long distance trip to rent a car from the office and drive to any necessary destination that cannot be reached by an alternative mode of transportation.

TRN Goal 3. Low Emissions Long Distance Travel

Members of the campus community often have to travel long distances on both personal and University business. While long-distance transportation accounts for a small proportion of campus transportation emissions, the University has the potential to achieve Net Zero emissions related to University long-distance travel.

TRN Objective 3.1. Eliminate unnecessary long distance trips

This area accounts for 1% of campus emissions, and includes both airline travel and car travel

TRN Strategy 3.1.1 Offer carbon offsets for long distance travel

Phasing: Mid
Sector Overlap: PPP
Co-Benefits: Educational, Public Health/Safety, Campus Climate, Environmental

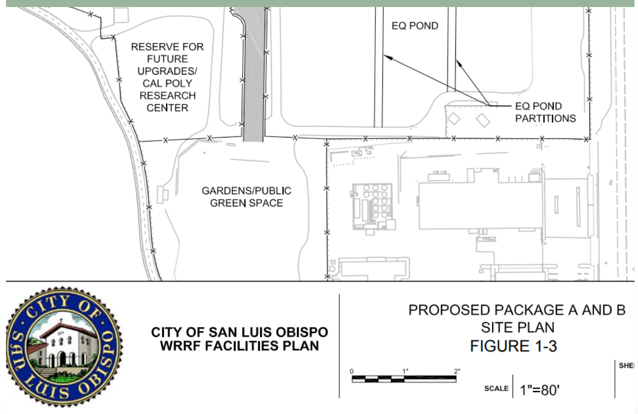
When professors and staff fly to conferences and meetings, they generate numerous GHGs. Departments pay for the carbon offsets to counteract those emissions. The carbon offsets can pay for projects by FM&D or grants towards sustainability-related projects such as senior projects or those completed by the EDES 408 (Implementing Sustainable Practices) class. Carbon Offsets are already used by many major airlines around the world as a way to offset their emissions. This strategy may offset GHG emissions by as much as .5% of the total transportation GHG emissions of Cal Poly—not including the additional reductions from programmatic investments.

Water

Cal Poly obtains water for agricultural, landscaping, and domestic uses from local reservoirs, groundwater sources, and surface water diversions. The University's primary water sources are Whale Rock Reservoir, Santa Margarita Lake (Salinas Reservoir), Nacimiento Reservoir and six on-campus groundwater wells (Cal Poly Master Plan, 2001; City of San Luis Obispo, 2015). GHG emissions within the Water Sector result from energy used for extraction and transport of water and the water treatment facility in Stenner Canyon, where electricity is used to treat and process water. Additionally, energy is used for the treatment of wastewater at the San Luis Obispo Water Reclamation Facility. Approximately 120 MTCO2e are emitted annually from water related processes on campus (Cal Poly GHG Inventory, 2015).

Currently, the University consumes 465 million gallons of water per year. Approximately 54% of Cal Poly's annual water usage supports agricultural use, 27% for landscaping, and 17% serves domestic consumption. The remaining 2% is used for various process uses (Cal Poly GHG Inventory, 2015).

The University has already taken measures to reduce water consumption. In 2015, a Drought Response Plan was adopted in response to the ongoing, multi-year drought in California. The plan calls for a 25% reduction in water consumption by 2016 as compared to the 2013 baseline (Cal Poly, 2015). The plan focuses on improved systems efficiency and behavior change to reach the University's water conservation goals. Some of the highlights of this plan include removing underutilized lawns, pursuing drip-irrigation, and planting drought conscious or native landscapes (R. Hostick, personal communication, November 12, 2015).



Identity	Name	GHG 2040 Reduction (MTCO2e)
WTR Goal 1	**Responsible stewardship of campus water serving landscaping, agricultural, and domestic uses**	
WTR Objective 1.1	*Reduce landscaping water emissions by 95% by 2040*	
WTR Strategy 1.1.1	Remove 40 acres of turf on campus	36
WTR Strategy 1.1.2	Install infrastructure for conveying untreated water for landscaping	0.3
WTR Strategy 1.1.3	Plant water efficient landscapes.	N/A
WTR Strategy 1.1.4	Create educational water conservation landscapes.	N/A
WTR Objective 1.2	*Reduce agricultural water emissions by 40% by 2040.*	
WTR Strategy1.2.1	Replace outdated infrastructure resulting in water leakage in agricultural fields.	6
WTR Objective 1.3	*Reduce domestic water emissions by 40% by 2040.*	
WTR Strategy 1.3.1	Prepare a water efficiency plan for structures on campus.	9
WTR Goal 2	**Resilient and prepared for variable precipitation and weather patterns**	
WTR Objective 2.1	*Prepare for increased flood risk and expanded flood plains by 2020.*	
WTR Strategy 2.1.1	Develop a comprehensive Flood Risk Management Plan.	N/A
WTR Strategy 2.1.2	Prioritize and implement the strategies and policies of the Flood Risk Management Plan.	N/A
WTR Objective 2.2	*Prepare for increased droughts by 2030.*	
WTR Strategy 2.2.1	Establish educational outreach initiatives and incentives to encourage personal and departmental water conservation.	5
WTR Strategy 2.2.2	Implement annual water allowances for campus departments, colleges, and other entities, and penalize entities that exceed their allotment.	N/A
WTR Strategy 2.2.3	Improve water fixtures to reduce consumption.	N/A
WTR Strategy 2.2.4	Pursue water reclamation research adn partnership opportunities	N/A

The Climate Action Plan expands upon the policies established in the Drought Response Plan and provides additional strategies for water reduction. An important focus is the impacts of climate change on the region's weather and rainfall patterns. The scientific community predicts climate change creates more variability in the state's climate, with more intense storms, longer dry periods, and less snowpack (Howard, 2014, p.1). As such, the University must prepare for both increased drought and flooding events and the associated impacts on the University's campus.

Outreach

All outreach events indicated shared concern and interest by participants in campus water use. The campus community supports water conservation and efficiency in infrastructure, agriculture, use within buildings, and landscaped areas, as indicated by staff interviews, surveys, and events. Feedback from the community was inspiring and inventive, receiving recommendations for campus to pursue gray, recycled, and rain capture water technology in the various community events. Participants in outreach events supported tracking campus housing water usage, retrofitting inefficient plumbing, and expanding the turf reduction program. A campus mapping activity at the UU Plaza indicated strong place attachment to landscaped areas such as the Rose Garden and Dexter Lawn. Of 520 participants, 143 supported increasing turf reduction to all campus lawns, except Dexter, the Library, and UU turf areas.

Informal surveys indicated that students who live off campus are more likely to engage in water conservation behaviors, potentially because students are more likely to be paying their own water bill. Open-ended survey respondents were concerned about drainage on campus, potentially indicating a need for flood mitigation. The majority of students surveyed could identify the turf reduction program as a response to current drought conditions and were largely pleased with the program's progress. However, the majority also expressed that Cal Poly could engage the student body more on water conservation strategies.

The Water Sector Team met with Ron Hostick, Dennis Elliot, and Kim Busby-Porter to discuss water usage on campus. These meetings informed the team of current policies and practices concerning campus water usage. Dennis Elliot, Director of Energy, Utilities, and Sustainability, explained current efforts considering the installation of a water reclamation facility on campus; however, this is not currently a priority. Water meters are necessary for all campus housing buildings to monitor direct usage. Water meters are expensive to install and since Cal Poly is on track to meet water reduction requirements set by the State and the Cal State University (CSU) system there is no immediate incentive to make the investment.

Ron Hostick, Landscape Manager, recommended increased landscaping water efficiency, including lawn removal, drip irrigation for all trees, and drought conscious, native landscapes. Kim Busby-Porter, Water Quality Management Specialist, discussed Cal Poly's water system, its connection to agricultural water usage, and the potential conservation strategies campus could pursue. Water misuse and waste in agriculture is primarily illustrated in leaky and old irrigation pipes. For alternative water management, Busby-Porter shared that current gray water quality standards are too stringent, creating a technological and financial barrier to pursuing such strategies on campus.

Strategies

WTR Goal 1. Responsible stewardship of campus water serving landscaping, agricultural, and domestic uses

Water conservation practices include technological improvements, improved water use awareness, and efficiency. Strategies to reduce water conveyance and treatment demand, which results in reduced GHG emissions and helps Cal Poly prepare for an insecure water future.

WTR Objective 1.1. Reduce landscaping water emissions by 95% by 2040.

Landscaping on campus accounts for 40% of Cal Poly's water-related GHG emissions (Cal Poly Greenhouse Gas Inventory, 2015). This water is treated to human consumption quality and conveyed around campus, requiring 272 MWH of electricity annually (Cal Poly Greenhouse Gas Inventory, 2015).

WTR Strategy 1.1.1. Remove 40 acres of turf.

Phasing: Mid
Sector Overlap: Campus Life
Co-Benefits: Financial, Environmental, Education

Cal Poly currently maintains approximately 48 acres of grass. The majority of this grass comprises the sports fields, the remainder is located within the campus core. Replacing the majority of grass on campus, including the sports complex fields with either synthetic turf or drought tolerant landscaping would remove 40 acres (83%) of grass on campus. Current turf and proposed turf reduction is illustrated in (Fig. WTR 1). No longer treating 40 acres of landscaping reduces conveyance and treatment electricity consumption by 272 MWh annually, which removes 47 MTCO2e of emissions.

Figure WTR1 Turf reduction transforms the campus landscape. [Ash-Reynolds, T. (Photographer). 2016, January. San Luis Obispo, CA]

WTR Strategy 1.1.2. Install infrastructure for conveying untreated water for landscaping.

Campus utilizes treated water for all campus core landscaping and untreated water for the recreational fields. Utilizing untreated water for campus core landscaped areas would significantly reduce treated water volume and associated electricity usage (Cal Poly, 2015). Installing new water conveyance infrastructure to the campus core from the untreated water distribution system is required. Based on the cost of replacing outdated infrastructure in agricultural fields, the cost of adding approximately 25,000 linear feet of untreated water piping would cost the University approximately $5,000,000 (Cal Poly, 2015). Installation of infrastructure and utilization of untreated water for remaining landscaping reduces the embedded energy use from irrigating landscape with treated potable water by 147 MWh.

Phasing: Mid
Sector Overlap: N/A
Co-Benefits: Financial, Environmental

WTR Strategy 1.1.3 Plant water efficient landscapes.

Phasing: Near
Sector Overlap: Building
Co-Benefits: Financial, Environmental

The Cal Poly Drought Response plan recommends future landscaping to "be replanted with native and drought tolerant plant species" (Cal Poly, 2015, p.3). Building on this recommendation and strategies 1.1.1 and 1.1.2, this strategy requires replanting of previous turf landscapes. These measures are to be implemented alongside turf reduction and landscape irrigation strategies to minimize aesthetic impacts. Cal Poly students responded positively in favor of further turf reduction measures and water efficient landscapes during outreach events.

Figure WTR2 Recently planted water efficient landscape outside Building 38. [Ash-Reynolds, T. (Photographer). 2016, January. San Luis Obispo, CA.]

WTR Strategy 1.1.4. Create educational water conservation landscapes.

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Public Heath/ Safety, Educational

New water efficient landscapes include signage identifying plants and the purpose of the landscaping, serving to educate the campus community and inform them of campus efforts to conserve water (Cal Poly, 2015). This strategy builds on policies already pursued by the university such as the current turf reduction signage, strengthening campus perceptions about water conservation programs. The strategy is to be implemented concurrent with Strategy 1.1.3. This strategy supports GHG emission reductions through water conservation outlined in Strategy 1.1.1.

WTR Objective 1.2. Reduce agricultural water emissions by 40% by 2040.

Agricultural water usage accounts for approximately 23% of water-related GHG emissions (Cal Poly Greenhouse Gas Inventory, 2015). Agricultural crops for non-human consumption (Feed) uses untreated water, meaning that reducing water consumption does not reduce treatment costs. All agricultural water not pumped from campus wells is conveyed from Whale Rock Reservoir but not treated for domestic purposes. The conveyance of this water accounts for approximately 46 MTCO2e annually. Due to the educational component of the agricultural water usage on campus, larger water reductions are not currently feasible. This objective also helps CAFES and the campus prepare and adapt to potentially more stringent water restrictions in the future.

WTR Strategy 1.2.1. Replace outdated infrastructure resulting in water leakage in agricultural fields.

Phasing: Mid
Sector Overlap: Agriculture
Co-Benefits: Financial, Environmental

A large amount of water is lost each year due to damaged or outdated infrastructure. This amount is difficult to estimate due to a lack of metering. Additionally, damaged and outdated infrastructure is more prone to blowouts and other failures, which tend to warrant costly repairs (Cal Poly, 2015). FM&D estimates that approximately 8,000 feet of aging 12-inch water main pipes need to be replaced to rectify the problem. The longer this aging infrastructure remains in the ground, the worse the issue becomes. Replacing the aging infrastructure should begin within the next five to ten years. Water and GHG emission reductions are difficult to estimate due to the lack of aforementioned quantification, but the reduction or elimination of the possibility of large scale blowouts and leaks significantly reduces the likelihood of significant water loss due to failures.

WTR Objective 1.3. Reduce domestic water use by 40% by 2040.

Domestic water use accounts for approximately 37% of Cal Poly's water related emissions (Cal Poly Greenhouse Gas Inventory, 2015). All domestic water is treated, increasing the GHG emissions associated with this use. Reducing water consumption and use provides valuable reductions in Cal Poly's water related emissions.

WTR Strategy 1.3.1. Prepare a water efficiency plan for structures on campus.

Phasing: Near
Sector Overlap: Building
Co-Benefits: Public Heath/ Safety, Financial

The Cal Poly Drought Response Plan identifies inefficient fixtures and appliances such as faucets, showerheads, toilets, and washing machines. Addressing this issue varies due to the different lifespans of buildings on campus. Replacing fixtures within the residence halls is the first priority and can begin immediately due to their assumed lifespan. A comprehensive document should be prepared in the next five years indicating which buildings on campus are the most outdated in terms of water efficiency and create a prioritized list of buildings not slated for removal and have outdated and water inefficient appliances.

WTR Goal 2. Resilient and prepared for variable precipitation and weather patterns

Flooding and drought events are potential threats to the Cal Poly campus. The risk and impact of these events can be mitigated through preventative planning and adaptation. Cal Poly has the ability to start preparing now for future extreme weather events that will affect campus.

WTR Objective 2.1. Prepare for increased flood risk and expanding floodplains by 2020.

The risk of flooding on Cal Poly's campus is increasing. Several campus resources and structures are currently located in Federal Emergency Management Agency (FEMA) defined flood zones, illustrated in [Figure WTR3]. Adaptation strategies need to be adopted to address the risk. At-risk buildings located within this FEMA defined floodplain include: 9 Farm Shop, 41-A Brown Engineering, 121 Cheda Ranch, 122 Parker Ranch, and 192 Engineering IV.

WTR Strategy 2.1.1 Develop a comprehensive Flood Risk Management Plan.

Phasing: Near
Sector Overlap: Campus Life, Buildings
Co-Benefits: Public Health/ Safety, Mobility

The development of a comprehensive Flood Risk Management Plan ensures Cal Poly responds to increased risk of floods brought about by climate change. The Flood Risk Management Plan has three objectives:

1. Analyze all structures and resources located in or near the floodplain and determine their ability to be resilient to future flooding;
2. Establish policies, as appropriate, to protect property and life ensuring resilience during a flood event; and
3. Develop an appropriate Flood Emergency Management Plan establishing procedures for flood events.

This plan is to be prepared by appropriately qualified professionals overseen by Cal Poly FM&D and be compatible with the objectives established in this Climate Action Plan and other University guidelines. The creation of the plan can begin as soon as possible, and should be completed by 2020.

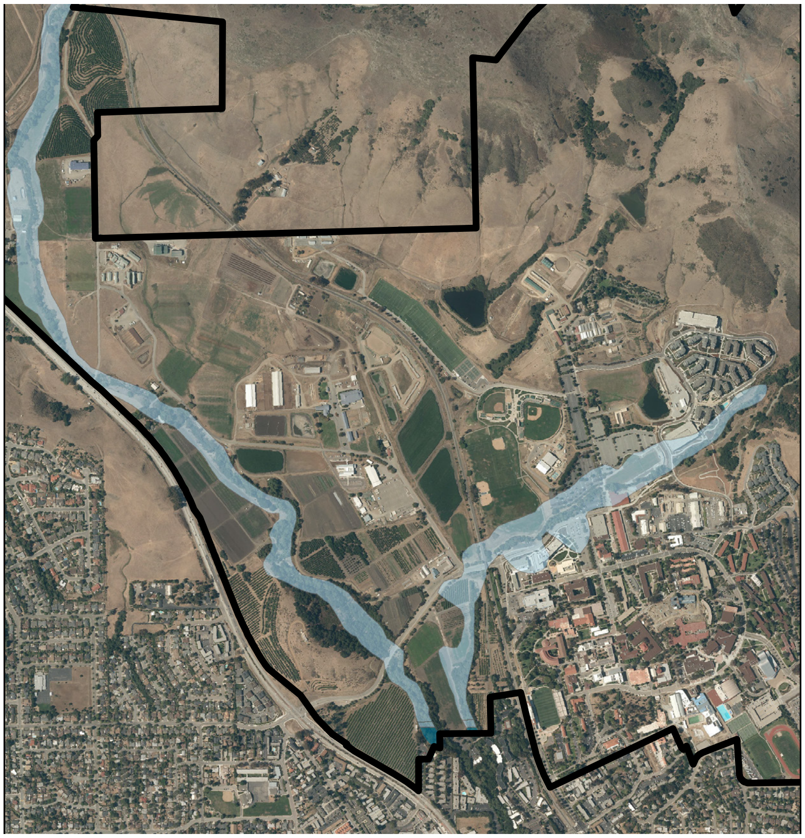


Figure WTR3 FEMA Flood Zones Map

WTR Strategy 2.1.2. Prioritize and implement the strategies and policies of the Flood Risk Management Plan

Taking into account the floodplain analysis conducted in the Flood Risk Management Plan, Cal Poly implements the strategies and policies established in the plan. The strategy ensures that Cal Poly is adequately prepared to deal with flood events on campus. In addition to establishing an Emergency Management Procedure for flood events, the plan establishes policies to ensure that campus is resilient to flooding events. Potential adaptive policies are summarized below. These policies are to be analyzed and refined in the Flood Risk Management Plan:

- Temporary barriers such as flood barrier systems and sandbags to prevent damage to property located within floodplains.
- Flood hazard retrofits or relocation of buildings located in the floodplain, based upon the findings of the structures analysis in the plan.

Phasing: Near
Sector Overlap: Campus Life, Buildings
Co-Benefits: Public Health/ Safety, Mobility

WTR Objective 2.2. Prepare for increased drought by 2030.

Cal Poly is already preparing for increased and prolonged drought events. The adopted Drought Response Plan has achieved over 25% water consumption reduction. The objectives and strategies in this document further these current efforts to reduce consumption.

WTR Strategy 2.2.1. Establish educational outreach initiatives and incentives to encourage personal and institutional water conservation

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Campus Climate

Educational initiatives and campus wide incentives are established in an effort to reduce water consumption. These programs aim to increase the Cal Poly community's awareness of their water consumption patterns and the possibility of drought. Educational outreach programs and signage campaigns highlight how individuals, departments, and other campus organizations can reduce water consumption. The outreach strategy initiates dialogue about climate change impacts on California's climate and water supplies in order to facilitate a greater awareness and understanding of the threats posed by climate change at a local and state level. The ultimate objective of such a campaign should be to empower behavioral changes that lead to a reduction in water use by individuals and departments on campus.

WTR Strategy 2.2.2 Implement annual water allowances for campus departments, colleges, and other entities, and penalize those entities that exceed their allotment.

Phasing: Near
Sector Overlap: Building
Co-Benefits: Financial, Environmental

All University departments and colleges are to be given a water allotment by the University administration and FM&D based on past use. The allotment is evaluated annually and is proportional to the department/college's need and current use levels. If a department, college, or other University entity exceeds their water allowance, they are to be penalized with financial obligations to pay for the excessive water use. This encourages campus entities to take "ownership" of their water use and to be responsible for their water use patterns. This strategy assumes water meters have been installed for all participating departments.

WTR Strategy 2.2.3. Improve water fixtures to reduce consumption.

Phasing: Mid
Sector Overlap: N/A
Co-Benefits: Financial, Environmental

As per the 2015 Drought Response Plan, all academic and housing facilities yet to be retrofitted with low flow plumbing fixtures should be retrofitted. These improvements are consistent with the objectives and structural improvements listed in the 2001 Cal Poly Master Plan and the 2015 Drought Response Plan.

Improvements to landscape irrigation technology and plant selection follows the policies established in Objective 1.1. Additionally, a wireless irrigation control system expanded to all zones of campus by 2020 as established in the 2015 Drought Response Plan.

WTR Strategy 2.2.4. Pursue water reclamation research and partnership opportunities

Phasing: Long
Sector Overlap: Campus Life
Co-Benefits: Educational

Cal Poly FM&D is evaluating potential use of reclaimed water from the California Men's Colony Wastewater Treatment Facility near Cuesta College for irrigation of Chorro Creek Ranch and the possibility of partnering with San Luis Obispo Water Resource Recovery Facility (WRRF; Cal Poly, 2015). Pursuing water reclamation research by utilizing existing technology available through partnerships allows campus to investigate water reclamation through Cal Poly's Learn by Doing approach at a low cost to the University. Preliminary research allows Cal Poly to prepare for pursuit of a water reclamation facility on-campus. Utilizing recycled water reduces water demand and emissions associated with transporting and treating water from Whale Rock Reservoir. The San Luis Obispo WRRF is open to discussions regarding a satellite reuse facility to serve Cal Poly (City of San Luis Obispo, 2014). Pursuing partnerships engages the campus and students in preliminary water reclamation research and builds a solid foundation to support an on-site facility to be pursued in the future.

Solid Waste

Solid waste disposal at Cal Poly contributes to the campus' current overall GHG emissions. As a byproduct of solid waste disposed in landfills, methane (CH4) is produced, which contributes to campus GHG emissions. Cal Poly currently sends over 2,000 tons of waste annually to the Cold Canyon Landfill via San Luis Garbage Inc. Already, campus has demonstrated success at reducing solid waste generation. Cal Poly has a successful recycling program, diverting 72% of the campus' overall waste from being sent to Cold Canyon Landfill. Although the University is now meeting state standards, Cal Poly can do more to reduce its solid waste impact.

Cal Poly's Zero Waste Program, with the help of FM&D and the Zero Waste club, has begun to work toward becoming a Zero Waste campus. As part of this goal, Cal Poly composts landscape clippings and animal waste on campus, which it then uses and sells. Pre-consumer food waste from campus dining facilities is sent to the Engle and Gray composting facility in Santa Maria (approximately 300 MT/year). The strategies in this PolyCAP aim to bolster and expand existing Zero Waste efforts to help the University reach the goal of sending Zero Waste to landfills.

Cal Poly seeks to achieve Zero Waste goal by 2040. Achievement of this goal requires the campus community be proactive in solid waste management. Cal Poly must further educate its community and increase awareness of waste management. This awareness is critical to successful pursuit of expanded composting of food waste and improved recycling rates.

Identity	Name	GHG 2040 Reduction (MTCO2e)
SW Goal 1	**Cal Poly is a Zero Waste Campus**	
SW Objective 1.1	*Establish a campus culture of responsible waste disposal and divert 80% of waste to recycling by 2020.*	
SW Strategy 1.1.1	Create a waste management education booth manned by members of the Zero Waste Club during WOW, SLO Days, and Open House.	N/A
SW Strategy 1.1.2	Require an online course focused on recycling, composting, landfills and their associated effect on the climate.	N/A
SW Objective 1.2	*Broaden Cal Poly's solid waste management operations through new and existing programs throughout campus buildings by 2020.*	
SW Strategy 1.2.1	Extend the Zero Waste program campus wide.	142
SW Strategy 1.2.2	Increase Cal Poly's participation in solid waste competitions such as Recyclemania.	13
SW Strategy 1.2.3	Require reusable containers in all dining facilities.	2
SW Strategy 1.2.4	Explore compostable or recyclable materials for all packaging.	N/A
SW Objective 1.3	*Remove plastic bottles sold on campus by 2025.*	
SW Strategy 1.3.1	Renegotiate the Coca Cola contract.	N/A
SW Strategy 1.3.2	Install water bottle filling stations.	N/A
SW Objective 1.4	*Support construction and operation of an anaerobic digestion facility.*	
SW Strategy 1.4.1	Provide pickup and transport of food waste to campus anaerobic digestion facility.	AG sector

Outreach

Through meetings with staff members, the Solid Waste Team received valuable insight and supporting resources to understand waste management at Cal Poly and identify potential solutions. Eric Veium, Energy & Sustainability Analyst at Cal Poly, explained the campus' current Zero Waste Program, including the costs and benefits of implementation throughout campus. The Solid Waste Team also learned of the existing goal to provide bottle filling stations on every floor of every building on campus to reduce the amount of plastic bottles used on campus. Greg Yeo, Campus Dining Operations Manager, shared information about campus dining operations including the use of reusable containers in some of the dining facilities, as well as the possibilities for post-consumer food waste composing. The discussion with Campus Dining also revealed the Athletics Department's role in the University's contract with Coca-Cola.

The Solid Waste Team used the larger outreach events to gauge the level of knowledge the campus population had regarding solid waste management on campus. After the first major outreach effort and several meetings with staff, the team concluded that the infrastructure on campus needed to be updated to foster better understanding of waste management on and off campus. A critical motivator for reaching the campus Zero Waste goal is the Zero Waste Program, which is seen as a success in its limited implementation on campus. Feedback on specific solid waste strategies during outreach events revealed that students support of Zero Waste measures including the "Eliminate plastic bottles" strategy, having 286 respondent votes (about 11%).

Strategies

SW Goal 1. Cal Poly is a Zero Waste campus

Cal Poly achieves a 100% diversion rate, sending Zero Waste to landfills by 2040. This goal follows and extends the CSU system goal of achieving an 80 percent reduction in waste sent to landfills by 2020 (CSU, 2014).

SW Objective 1.1. Establish a campus culture of responsible waste disposal and divert 80% of waste to recycling by 2020.

The Cal Poly campus community is not currently utilizing all recycling or composting opportunities available to campus. Educating students, faculty, and staff about recycling and composting early on in their college experience and encouraging participation in existing solid waste competitions can improve student's awareness, as well as increase solid waste diversion rates from landfills.

SW Strategy 1.1.1. Create a waste management education booth staffed by members of the Zero Waste Club during WOW, SLO Days, and Open House.

This strategy works increases recycling rates on campus by building greater awareness of recycling practices among students. The cost of this strategy is minimal, with a large reliance on student involvement for success.

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Campus Climate, Community Cohesion

SW Strategy 1.1.2. Require an online course focused on recycling, composting, landfills and their associated effect on the climate.

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Educational, Campus Climate

This strategy implements a program similar to the existing Haven and Alcohol Wise programs (Cal Poly Campus Health and Wellbeing, 2016) required of all Cal Poly students, increasing education and awareness about recycling practices and waste reduction. The increase in awareness of solid waste issues on campus can lead to a larger solid waste diversion rate from landfills and reduce Cal Poly's overall GHG emissions.

SW Objective 1.2. Broaden Cal Poly's solid waste management operations through new and existing programs throughout campus buildings by 2020.

Currently, FM&D has implemented a Zero Waste Program, but has not implemented the program campus-wide. Expansion of this program can encourage changes in student behavior, resulting in a greater proportion of waste being properly disposed. Implementing support programs for the Zero Waste Program makes the goal of Zero Waste achievable.

SW Strategy 1.2.1. Extend the Zero Waste Program campus wide.

Phasing: Mid
Sector Overlap: Campus Life, Building
Co-Benefits: N/A

The cost of Zero Waste stations is limiting full deployment of the program. The current cost of a new Zero Waste station is between $1,000-$6,000. Through a redesign process of the stations and strategic placing, the cost can be lowered. This strategy has the potential to have a large effect on Cal Poly's overall waste diversion rate.

SW Strategy 1.2.2. Increase Cal Poly's participation in competitions such as Recyclemania.

Phasing: Mid
Sector Overlap: Campus Life
Co-Benefits: Educational, Campus Climate

This strategy establishes student campaigns to increase recycling rates on campus. Through student participation, competitions can lead to a broader awareness of recycling practices and create a culture of recycling on campus.

SW Strategy 1.2.3 Require reusable containers in all dining facilities

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Public Heath/ Safety

Requiring reusable containers to be used in all campus dining facilities works to reduce overall waste on campus and divert solid waste from being sent landfills. A brief fiscal and environmental analysis has been completed to project costs and benefits of requiring reusable food containers to be used in all campus dining facilities. A formal study for the implementation of this program will yield the feasibility, costs and benefits of the program.

SW Strategy 1.2.4. Explore using compostable or recyclable materials for all packaging.

Phasing: Mid
Sector Overlap: N/A
Co-Benefits: N/A

Currently, Cal Poly has no formal policy on the types of products and the associated packaging that can be sold on campus. Recycling candy wrappers and chips bags is inefficient due to the need for more equipment, which outweigh the benefit of such a program. This strategy necessitates an evaluation of alternative packaging and policies regarding the products can help Cal Poly's effort to reach Zero Waste.

SW Objective 1.3. Remove plastic bottles sold on campus by 2025.

Reducing the number of plastic bottles on campus increases waste reduction efforts and brings the University closer to the Zero Waste goal.

Strategy 1.3.1. Renegotiate the Coca-Cola Contract.

Phasing: Near
Sector Overlap: Campus Life
Co-Benefits: Financial

Renegotiate Cal Poly's current contract with Coca-Cola, requiring all vending machines on campus to be replaced with fountain drink vending machines, such as the Coca-Cola Freestyle. This reduces the overall use, and associated waste, of plastics bottles on campus, thereby reducing costs associated with recycling and waste disposal. This strategy depends largely on the strength of the deal reached with Coca-Cola.

Strategy 1.3.2. Install water bottle filling stations

Phasing: Near
Sector Overlap: Campus Life, Health/Safety
Co-Benefits: Financial, Campus Climate

Install water bottle filling stations to replace water bottles sold in vending machines, as well as plastic bottles sold elsewhere on campus. This strategy discourages the overall use of plastics bottles on campus, reducing costs associated with recycling on campus. The cost of this strategy comes from the labor and equipment necessary to install the water stations.

Objective 1.4. Support the construction and operation of an anaerobic digestion facility

Strategies AG 1.1.1 and AG 1.1.2 assess and pursue installation an anaerobic digester that combines agricultural and campus organic waste. The strategy below supports this effort.

SW Strategy 1.4.1. Provide pickup and transport of food waste to campus anaerobic digestion facility

Phasing: Long
Sector Overlap: Agriculture
Co-Benefits: Financial, Campus Climate

Implementing a program to collect all food waste from campus dining facilities and send it to the proposed anaerobic digester (AG 1.1.2) reduces overall GHG emissions associated with solid waste. Campus dining, in collaboration with FM&D collaborates to develop of collection and transportation system for food waste intended for the con campus digestion facility.

Campus Life

The Campus Life sector addresses GHG emissions and climate adaptation strategies related to campus community behavior in on-campus housing, academic buildings, dining, recreation, transportation, and health facilities. Causes of campus life GHG emissions are heating and electricity usage in on-campus housing, as well as the travel behavior of students, faculty, and staff to and from campus.

The University's 2014-2015 Academic Plan Report states that student population is expected to increase to 25,000 students, not including faculty and staff (Cal Poly, 2015). In Fall 2014, the University housed approximately 40% of all undergraduates and 98% of incoming freshmen in existing University Housing (University News & Information, 2016). The Draft Master Plan Update increases campus housing to 65% of all undergraduates with the possibility of requiring all first and second year students to live on campus. Cal Poly's future enrollment impacts all elements of campus life including on-campus housing, dining facilities, and other student services and amenities.

Among the University's efforts toward integrating sustainability and climate adaptation into residential life are programs such as "sustainability, energy and water conservation competitions, recycling competitions and community involvement" (Cal Poly FM&D, 2014, ¶49). A student lead group in the Red Brick dorms, "Eco Reps," includes representatives from each apartment neighborhood that have implemented "an environmental awareness tower in Sierra Madre, a quarterly newsletter, sustainability fairs, Zero Waste meals, a sustainability spa and craft nights" (List, 2011, ¶27). However, University Housing's most prominent program is the annual Red Brick Energy Competition. University Housing partners with the

Identity	Name	GHG 2040 Reduction (MTCO2e)
CL Goal 1	**An engaging campus environment**	
CL Objective 1.1	*Increase dining options on campus by 30%.*	
CL Strategy 1.1.1	Expand on-campus grocery options.	N/A
CL Strategy 1.1.2	Provide community gardens for university housing residents.	N/A
CL Strategy 1.1.3	Increase healthy dining options on campus.	N/A
CL Objective 1.2	*Expand entertainment options on campus by 2025.*	
CL Strategy 1.2.1	Develop a Poly Canyon Trail map and management plan.	N/A
CL Strategy 1.2.2	Expand on-campus nightlife.	N/A
CL Objective 1.3	*House more than 65% of the student body by 2025.*	
CL Strategy 1.3.1	Provide university housing surrounding the academic core.	16,757
CL Goal 2	**Climate Smart Campus Culture**	
CL Objective 2.1	*Reduce energy usage of student residents by 20% by 2025.*	
CL Strategy 2.1.1	Expand and move the Red Brick Energy Competition.	125
CL Strategy 2.1.2	Keep utility usage 10% less than baseline.	25
CL Objective 2.2	*Educate students, faculty, and staff about GHG emissions reduction.*	
CL Strategy 2.2.1	Host “Sustainability Tours” of campus.	N/A
CL Strategy 2.2.2	Create interactive renewable energy sources on campus with education components.	N/A
CL Goal 3	**A climate adaptive and resilient campus**	
CL Objective 3.1	*Implement climate change adaptation measures by 2025.*	
CL Strategy 3.1.1	Expand and develop hazard mitigation strategies related to climate change impacts.	N/A
CL Strategy 3.1.2	Educate the campus community on vulnerabilities caused by climate change.	N/A

Green Campus Program to facilitate competitions and educate campus residents on energy and water efficiency, as well as environmental stewardship in housing facilities. Despite the competition's popularity, it has been found that energy and water reductions drop during the three-week competition but return to normal shortly after it has ended, indicating a change in only short term behavior (S. Bloom, personal communication, February 19, 2016). Expanding and moving the competitions to when students first move onto campus is expected to better instill new habits into student's long-term behavior.

The University provides 12 different dining options in the University Union, six in Kennedy Library Neighborhood, eight in Vista Grande Neighborhood, and four in PCV. Dining facilities include restaurants, campus markets, and coffee shops; however, primary food options are limited to sandwiches, hamburgers, pizza, and sushi (Cal Poly Website, 2013). In a survey conducted by the PolyCAP Campus Life Team in Fall Quarter 2015, student respondents indicated that the type and price of food have the most influence on their on-campus dining choices. An article in the Mustang News reported that only 12 of the 314 entrées offered in Campus Dining locations are considered in good health, calling for an increase in healthy dining options (McCarthy, 2016). However, healthy local food is available to the campus community through the Horticulture Crop Science (HCS) department within CAFES, who currently hosts a bi-weekly Farm Market selling seasonal produce grown on campus. The HCS department also hosts "u-picks" in the campus orchards where students can pick their own mandarins, oranges, avocados, and other seasonal produce (K. Piper, personal communication, March 1, 2016). Cal Poly produces many products that are healthy and attractive to students. Expanding the availability of healthy, campus-grown goods and providing additional healthy dining options increases public health and student satisfaction.

Climate change is not only a matter of public health, but also a matter of public safety on campus. Climate change increases the risk of weather-related disasters such as drought and high intensity storms (Earth Observatory, *n.d.*). As stated in the Background Report, public health on campus is likely to be impacted by an increase in temperature and natural disaster frequency. Campus public health and safety are likely to be affected by students overheating and becoming dehydrated, reduced water availability, and an increased risk of wildfire and flooding.

The following goals, objectives, and strategies create a more inviting campus environment, educate students on climate smart practices, and adapt the campus community to climate change related hazards and health impacts. Creating a more engaging campus environment includes increasing amenities and dining options on campus as well as making the campus community more attractive to incoming students. Educating students on the impacts of climate change and Cal Poly's efforts toward a climate smart campus spurs the campus community's participation in adaptation and GHG reduction behaviors.

Outreach

Campus Life Team's outreach focused on gathering input on strategies related to the activities and amenities for the campus community. As part of the main outreach event, strategies such as community gardens and the dorm competition were listed on a poster for people to vote on. Out of the 12 proposed strategies, community gardens had the second most stickers, meaning there was large support by participants. The survey reflected the nightlife activities people would like to see on campus. The results varied, but some common results included a movie theater, lounge, and better dining options. Participants, overall, felt that the campus needs some more nightlife activities.

Campus Life has spoken with several individuals to obtain an understanding of how the Cal Poly campus operates including Scott Bloom (Associate Director of Housing, Director of Facilities), Dennis Elliot (Director, Energy, Utilities and Sustainability), and Carole Schaffer (Associate Director of Housing, Director of Residential Life). Elliot provided information on the funding and logistics of the dorm energy competition. Scott Bloom and Carole Schaffer were able to provide information and data regarding dorm utility use, the dorm energy competition, community gardens, and student behavior and attitudes around sustainability. These meetings provided specific information and data on strategies concerning campus life.

Strategies

CL Goal 1. An engaging campus environment

An engaging campus that provides activities, amenities, and services, creating a lively campus environment where students, faculty, and staff can live, work and play.

CL Objective 1.1. Increase dining options on campus by 30%.

Cal Poly currently has 18 food service outlets on a campus serving almost 23,000 students, faculty and staff (Cal Poly, 2014). The growing student population requires an increase in food and beverage facilities to serve the expected future population. With the addition of the following strategies, dining facility options on campus increase by 30% and provide a wider range of dining options on campus to encourage student, faculty, and staff to stay on campus for meals, reducing vehicle trips to and from campus.

CL Strategy 1.1.1. Expand on-campus grocery options.

Phasing: Mid
Sector Overlap: N/A
Co-Benefits: Campus Climate, Financial, Public Health/Safety

A grocery store in the campus core encourages on-campus living and promotes healthy eating in the campus community. College-aged adults take multiple trips to the grocery store per week (Supermarket Facts, 2016). Therefore, providing a grocery store on campus within walking distance to a large number of on-campus residents reduces the number of vehicle trips to grocery stores. Implementation of this strategy includes the addition of a 16,000 square foot grocery store.

Grocery stores on university campuses are not uncommon as they contribute to healthy independent on-campus living. The University of Wisconsin Madison added an independent grocery store in the ground floor of their University Square called Fresh Madison Market (Falkenstein, L, 2010). The store is 16,000 square feet with an additional 2,000 square feet on the second level devoted to a deli and other functions. Fresh Madison Market dedicates 50% of the store space to fresh produce, provides snacks, nuts, and dried fruit available by the pound from bins, and offers typical college student snacks as well as other products like basic cleaning products. A grocery store on campus caters to students, while also allowing University staff or anyone accessing the campus, to make a home-cooked meal.

CL Strategy 1.1.2. Provide community gardens for University Housing residents.

> ***Phasing:*** Mid
> ***Sector Overlap:*** N/A
> ***Co-Benefits:*** Campus Climate, Community Cohesion, Educational, Public Health/Safety

Campus gardens improve public health, food security, and dietary intake as well as allow students to grow produce for their own consumption. This strategy calls for the addition of 20 community gardens on campus, to be placed near all existing and future University Housing facilities. Individual students sign up quarterly to "rent" their plot of land and maintain the community garden placed near their housing facility. Students are responsible for maintaining their plot of land or forfeit their spot to another student on the waiting list. Each community garden location is equipped with a small gardening shed stocked with tools free for the students to use.

CL Strategy 1.1.3. Increase healthy dining options on campus.

> ***Phasing:*** Mid to Long
> ***Sector Overlap:*** Agriculture
> ***Co-Benefits:*** Community Cohesion, Environmental, Financial, Public Health/Safety

The expansion of healthy dining options includes the addition of six new food and beverage facilities as well as a weekly farmer's market on campus. Based on the current campus population to dining facility ratio, six new dining facilities are estimated as necessary to serve the future campus population. Dining facilities are placed in the academic core and future housing facilities, as specified by the Draft Master Plan Update. A weekly farmer's market, held in the Farm Shop (Building 9) sells produce from Cal Poly and local vendors. The farmer's market provides space for 10 to 15 vendors who apply to rent a space from CAFES. Goods sold at the farmer's market include produce currently available at the Crops Unit on campus as well as produce from off-campus local vendors and other CAFES departments. This strategy encourages healthy eating and public health on campus by bringing fresh produce to campus residents and serving as a form of revenue for CAFES.

CL Objective 1.2. Expand entertainment options on campus by 2025.

Requiring additional students to live on campus requires an increase in University Housing stock. Making this scenario attractive to incoming students calls for a significant increase in on-campus amenities and entertainment options.

CL Strategy 1.2.1. Develop a Poly Canyon Trail map and management plan.

> ***Phasing:*** Near
> ***Sector Overlap:*** N/A
> ***Co-Benefits:*** Campus Cohesion, Educational, Mobility, Public Health/Safety

The Cal Poly campus has many outdoor recreational opportunities including hiking trails in Poly Canyon; however, many of the trails are unmarked and difficult for hikers unfamiliar with the area to find. The Poly Canyon Trail plan makes trails easily accessible, encourages outdoor recreation, and improves public health on campus. The Poly Canyon Trail map provides maps of each trail including information such as trail length, elevation changes, and appropriate modes of transportation. In addition to mapping the trails, this strategy includes the placement of wayfinding signage and informational placards throughout the trails creating an educational element to the project. Educational content for informational placards can be provided by Cal Poly faculty in relevant fields. Wayfinding signage is necessary as it is a safety concern to have unmarked trails. This strategy increases the usage of the trails, further increasing the safety of those hiking alone.

CL Strategy 1.2.2. Expand on-campus nightlife.

Phasing: Mid
Sector Overlap: Transportation
Co-Benefits: Campus Climate, Community Cohesion, Financial

In accordance with the Master Plan Update, Cal Poly should increase on campus amenities including nightlife activities to make living on campus attractive to its growing on-campus resident student population. In a survey conducted by the PolyCAP team in February 2016, respondents were asked what kind of nightlife activities they would like to see on campus. The most popular responses included a movie theater, restaurants and lounge areas. Other suggestions included a club-like experience for those 21 and over, laser tag, and an adaptive space to be used for concerts, performances, and other small scale events.

CL Objective 1.3. House more than 65% of the student body by 2025.

A key guideline for the Draft Master Plan Update process states that "more than 55% of student enrollment are housed in University managed Housing (Cal Poly, 2014, p.2)." Similarly, as stated in Objective 1.1, Cal Poly intends to increase its student body to 25,000 by 2035. This significant increase in student population calls for an increase in on-campus student housing. Housing students on campus decreases vehicle trips to campus, reducing GHG emissions.

CL Strategy 1.3.1. Provide University Housing surrounding the academic core.

Phasing: Long
Sector Overlap: Transportation
Co-Benefits: Community Cohesion, Financial

In order to supply on-campus housing for Cal Poly's projected student population, the University increases the supply of student housing on campus to accommodate approximately 6,000 new students. Providing this housing close to the academic core, in accordance with the University's Draft Master Plan Update, makes living on campus more attractive to students.

CL Goal 2. Climate Smart Campus Culture

A Climate Smart Campus Culture increases the campus community's awareness of climate change and adaptation behaviors.

CL Objective 2.1. Reduce energy usage of student residents by 20% by 2025.

Because on-campus residents do not pay utility bills separately from rent, they are likely to be unaware of their energy usage. Subsequently, excessive energy is often used in University Housing. An increase in the number of students practicing energy conserving habits reduces electricity, water, and waste from campus dorms and apartments. The following strategies improve existing University Housing programs and increase participation in climate smart behaviors by the campus community.

CL Strategy 2.1.1. Expand and move the Red Brick Energy Competition.

Phasing: Mid
Sector Overlap: Solid Waste, Water, Buildings
Co-Benefits: Educational, Financial, Campus Cohesion

Expanding and moving the Red Brick Energy Competition to another time of year increases its efficiency. The competition can be held during the beginning of the school year to increase student participation and help develop energy conserving habits immediately after move-in. Results from the 2014 competition illustrate a slightly higher water usage than the baseline amount in Sequoia and Santa Lucia hall (Lucid Design Group, 2014). This is because the baseline amount was measured during a lower academic stress period. Currently, the competition is held in February, during a time that is academically stressful for students entering midterm season. Consequently, many students care less about the dorm competitions (Jon, 2014).

Holding the competitions in September, at the beginning of the school year, can more greatly decrease the amount of energy usage because it is during a less academically stressful period. Furthermore, habits are formed when a chosen behavior is repeated in the same context, until it becomes automatic and effortless (Gardner, B., Lally, P., & Wardle, J., 2012). This encourages students to practice and repeat behaviors learned during the competition throughout the school year to establish habits. Expanding the competition to all housing facilities educates more students, thereby saving a greater amount of energy across campus. A reduction in housing facility's utility usage indicates the effectiveness of this strategy. Utility usage needs to be monitored and compared every year to quantify GHG reduction, requiring the installation of meters for every housing facility; the strategy for meter installation is explained in Strategy BDG 1.1.1.

CL Strategy 2.1.2. Keep utility usage 10% less than baseline.

Phasing: Mid
Sector Overlap: Water, Building
Co-Benefits: Educational, Financial

Rewarding students for reducing their utility usage helps maintain the utility-conserving habits developed during the dorm energy competitions, as explained in Strategy 2.1.1. This works in the form of students receiving benefits if they reduce their utility usage by 10% on top of utility usage reduced during the energy competitions. Therefore, the baseline can be set based on energy competitions. Incentives for keeping utility usage low include music/concert ticket giveaways or priority tickets for campus sporting events. Due to financial constraints, monetary incentives are complicated and difficult to implement; therefore, this strategy promotes non-monetary rewards, leaving room for additional educational opportunities (C. Schaffer, personal communication, February 19, 2016). Because the metering system tracks the energy usage of the whole residence hall, all the students in the residence halls that achieve the reduction can receive the benefits.

CL Objective 2.2. Educate students, faculty, and staff about GHG emissions reduction.

In order for Cal Poly to cohesively move forward with climate action measures, the campus community needs to be aware of the University's accomplishments in these areas. Additionally, the campus community needs to be educated on adaptation measures and GHG reduction strategies they can perform on a personal level.

CL Strategy 2.2.1. Host "Sustainability Tours" of campus.

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Educational, Community Cohesion

Tours showcasing Cal Poly's efforts to reduce GHG emissions and adapt to climate change educates not only the current campus community, but visitors, as well. Addressing climate change shows students, faculty, staff and visitors that the University is serious about being a leader in climate action. This strategy also increases general education about climate change, adaptation measures, and GHG emissions reductions. The cost is estimated to be minimal to implement the new tour as it is integrated into existing campus tours such as WOW and Poly Reps. The Sustainability Tours requires one tour guide, who is educated on climate action, to join existing tours. The tours bolster and maintain campus support for climate-friendly actions.

CL Strategy 2.2.2. Create interactive renewable energy sources on campus with education components.

Phasing: Near
Sector Overlap: Renewable Energy
Co-Benefits: Educational, Campus Climate

Interactive solar and bicycle-powered charging stations, alongside educational diagrams/plaques, save energy and increase student awareness of renewable energy on campus. This strategy consists of separable parts, so the bulk of its cost is the planning and installation of solar and bicycle powered charging stations. Pairing the solar powered electronics charging stations with lockers are highly recommended because it is the most suitable model for students. At least five solar powered charging stations are needed to be distributed throughout the campus to be accessible for any location. For bicycle powered charging stations, three stations are recommended to support the solar power stations.

Each part of the strategy is treated as a standalone outreach program, but work best when organized in a synchronized and cohesive manner. Solar powered charging stations and bicycle powered energy sources can reduce GHG emissions by replacing a small part of current carbon-emitting energy sources.

CL Goal 3. A climate adaptive and resilient campus

An adaptive campus is one that has capacity for adjustment to new conditions and environments. Climate resilience is the capacity for social-ecological systems to sustain shocks and maintain its social, public health, and public safety systems.

CL Objective 3.1. Implement climate change adaptation measures by 2025.

In order for campus to function efficiently in an event caused by climate change, Cal Poly must have a plan for adaptation and services that foster the plan. As mentioned in the Additive Capacity Assessment of the PolyCAP Background Report (2016), "There is a high adaptive capacity if the community has already taken steps to adapt and is well prepared in that there are plans and mitigation measures already implemented and a low adaptive capacity if the community has not recognized the coming impact, and has no plans to address it," (p.21). Additionally, the campus community needs to be informed and educated on risks related to climate change and how to prepare themselves. The success of adaptation is the existence and implementation of a plan. Continuing success is indicated of students having no health effects or injuries caused by climate change.

CL Strategy 3.1.1. Expand and develop hazard mitigation strategies related to climate change impacts.

Phasing: Near
Sector Overlap: Agriculture, Building, Water
Co-Benefits: Community Cohesion,Environmental, Public Health/Safety

Cal Poly's Emergency Management Multi-Hazard Preparedness Plan (CP EMP) was created in the event that the health, safety, and/or property of the public within the operational area of the University was impacted due to a major disaster or emergency (Cal Poly Emergency Management Multi-Hazard Preparedness Plan, 2015). Although the plan addresses various hazards and how they affect the University, it does not address the progressive nature of climate change impacts, which change with time. In addition to having adaptation measures, the campus community needs to be educated and informed about hazard risks related to climate change and how to respond to these hazards. By implementing adaptation measures and addressing health issues, the campus community is prepared and there is minimal risk or damage from future disasters or emergencies.

The plan is carried out in two phases: the first in which the plan is developed and the second in which the plan is implemented. The CP EMP protects and reduces impacts on the campus community and property. The effectiveness of the plan is checked based reductions of health effects and injuries due to climate change over time.

CL Strategy 3.1.2. Educate the campus community on vulnerabilities caused by climate change.

Phasing: Near
Sector Overlap: N/A
Co-Benefits: Community Cohesion, Educational, Public Health/Safety

Educating the campus community about how to protect themselves from potential climate change impacts such as heat-related health risks prepares campus for when disasters or extreme weather events occur. Although the CP EMP mentions hazards and weather events related to climate change, there is minimal information and protocol on health effects. Through additional Health Center training and programs (i.e. workshops, pamphlets, and informational guest lectures), the campus community is educated and prepared in the event of a hazard. A Draft Master Plan Update principle under Campus Life mentions, "Health and wellness among the campus community should be encouraged by providing a variety of types of opportunities to engage in healthy behaviors," (Draft Master Plan Update, 2015, p.8). As an ongoing Administrative Policy, the University is responsible for providing services and education that facilitate health and wellness.

Although Cal Poly already has a Health Center that provides services, it takes a year or two to expand and build upon the services to incorporate an educational component. The Health Center monitors percent reductions of health effects and injuries due to climate change over time.

Renewable Energy

Currently, 92% of electricity used by campus is purchased from PG&E and the other 8% is generated on campus through photovoltaics (PV) and cogeneration (Cal Poly, 2014). The Renewable Energy sector intends to generate electricity using renewable sources, including wind and solar energy. The target of Net Zero by 2050 requires onsite energy generation and a transition from fossil fuels to renewable energy.

By design, renewable resources release little to no GHGs and are often cheaper in the long run rather than having dependence on electricity providers such as PG&E. It should be noted that PG&E is a comparably clean producer. Its energy sources are 47% natural gas, 20% nuclear, 16% large hydroelectric, 15% eligible renewable, 2% coal, and 1% other resources. Eligible renewables include biomass, geothermal, small hydroelectric, PV, and wind power (Cal Poly, 2014).

Many strategies within the Renewable Energy sector are meant to remove barriers and streamline the installation of renewables. This is meant to aid projects that are already planned as well as provide a gateway for unforeseen projects. A key to this strategy is renegotiation with PG&E to allow more energy production on campus.

Separate from the PolyCAP, Cal Poly is planning to implement a 5 megawatt solar farm on Cal Poly land to increase the use of renewable energy. The dollar value of the electricity generated from the solar farm is going to be transferred as credit to the Mustang Substation (D. Elliot, personal communication, November 2, 2015). Cal Poly is also researching the feasibility of a wind farm on Cal Poly land.

Identity	Name	GHG 2040 Reduction (MTCO2e)
RE Goal 1	**Renewable energy sources efficiently power campus needs**	
RE Objective 1.1	*Balance energy produced on campus and energy provided by PG&E to be Net Zero by 2050*	
RE Strategy 1.1.1	Re-negotiate terms with PG&E.	N/A
RE Strategy 1.1.2	Apply for PG&E RES-BCT program.	N/A
RE Objective 1.2	*Increase the capacity and efficiency of the GRID.*	
RE Strategy 1.2.1	Begin research and analysis of microgrid feasibility.	N/A
RE Strategy 1.2.2	Install a microgrid on campus.	417
RE Goal 2	**Implemented renewable energy practices on both campus land and buildings**	
RE Objective 2.1	*Increase implementation of solar energy panels on existing infrastructure.*	
RE Strategy 2.1.1	Outfit parking structures with solar arrays on the top level.	228
RE Strategy 2.1.2	Research the feasibility of solar panels on existing buildings.	137
RE Strategy 2.1.3	Install rooftop solar arrays on identified buildings.	982
RE Objective 2.2	*Build renewable energy infrastructure on campus-owned land.*	
RE Strategy 2.2.1	Maximize the solar energy implementation effort to ensure a 5MW array.	1,026
RE Strategy 2.2.2	Implement the Cal Poly Wind Farm.	N/A
RE Strategy 2.2.3	Research and implement new energy storage strategies.	N/A
RE Goal 3	**A campus with educational practices that promote utilization and production of renewable energy sources**	
RE Objective 3.1	*Pursue new renewable energy technology as part of academic curriculum.*	
RE Strategy 3.1.1	Expand curriculum related to renewable energy and storage.	N/A

Cal Poly needs these renewable energy projects, along with others, to respond to climate change impacts and to reach the Net Zero goal of the PolyCAP. Increased temperature and heat waves create higher demand for air conditioning; therefore, campus needs to increase efficiency and renewable energy generation to meet these rising demands.

Outreach

Outreach was a key resource to both educate the community on the climate action plan and to solicit feedback. In total, there were 522 responses from a combination of students, faculty, staff, and community members. Of these 522 responses, 137 of the respondents supported an increase in student fees to help fund solar power on campus and 307 of the respondents supported wind turbines on University land. Even though the installation of wind energy is not yet as far along in development as the establishment of a solar array, the clear support for wind energy demonstrates that Cal Poly can and should continue to pursue wind energy in addition to solar.

The Renewable Energy sector had two main contacts throughout the process: Eric Veium and Dennis Elliot. Eric Veium is the Energy and Sustainability Analyst for the FM&D and Dennis Elliot is the Director of Energy, Utilities, and Sustainability. These two individuals offered vital information that affected each strategy. Topics covered with them included: solar energy logistics, wind energy research and logistics, solar panels on building, educational aspects of renewable energy, Cal Poly's PG&E contract, and energy efficiency on campus.

Strategies

RE Goal 1. Renewable energy sources efficiently meet campus needs

In order to utilize renewable sources, Cal Poly's grid system must effectively store and distribute energy. The University must also ensure that contractually, Cal Poly is allowed to do this by re-negotiating the current agreement with PG&E.

RE Objective 1.1. Balance energy produced on campus and energy provided by PG&E to be Net Zero by 2050

Cal Poly's current contract with PG&E prevents off-campus distribution of excess energy, as well as charging per kW of energy produced on-site (FM&D, 2015, p. 12). In order to control the source and distribution of energy, Cal Poly must renegotiate its contract with PG&E.

RE Strategy 1.1.1. Re-negotiate terms with PG&E

Phasing: Mid
Sector Overlap: Agriculture, Building, Campus Life, PPP, Solid Waste, Transportation, Water
Co-Benefits: Campus Climate, Financial, Environmental

Cal Poly's current agreement with PG&E prevents off-campus distribution of excess energy, as well as charging the campus per kW for energy produced on-site (FM&D, 2015, p. 12). In order to control the source and distribution of energy, Cal Poly needs to transition its contract with PG&E toward a Net Energy Metering service agreement. Reevaluation of the PG&E agreement allows the University to decrease its reliance on PG&E and take initiative to become an independent source of clean power. The University could give energy back to the community, depending on the City of SLO's involvement in PG&E's RES-BCT program (see Strategy 2.1.2). A new relationship with PG&E allows Cal Poly to construct a microgrid and utilize renewable sources of energy produced onsite. This strategy ultimately gives Cal Poly the ability to choose its energy sources and distribute renewable energy. Cal Poly will only rely on the PG&E grid when peak demand exceeds the amount of energy produced onsite.

RE Strategy 1.1.2 Apply for PG&E RES-BCT program.

Phasing: Mid
Sector Overlap: Building
Co-Benefits: Financial, Environmental

The PG&E Local Government Renewable Energy Self-Generation Bill Credit or Transfer Program (RES-BCT) allows a local government (including CSU campuses) to export any excess energy to the grid and receive generation credits in return. By participating in RES-BCT, Cal Poly can produce and utilize energy produced onsite and distribute excess supply to the City. Although this strategy does not directly reduce GHG emissions, it effectively offsets emissions by providing excess renewable energy to the City of SLO. FM&D is responsible for fostering the partnership with the city and encouraging them to apply for the program. The success of this strategy is measured by the number of credits given back to the grid.

RE Objective 1.2 Increase the capacity and efficiency of the GRID.

Cal Poly must reduce demand and increase the MWh produced by renewables. Achieving Net Zero requires the GRID to efficiently distribute the energy the Campus produces from renewable sources (Cal Poly, 2015).

RE Strategy 1.2.1. Begin Research and Analysis of microgrid feasibility.

Phasing: Near
Sector Overlap: Building
Co-Benefits: Educational, Campus Climate

A microgrid draws its energy from renewable sources (i.e. solar, wind, co-gen, batteries, etc.) on campus. The implementation of a microgrid would allow Cal Poly to produce, store, and distribute its own energy from renewable sources.

Savings eventually outweighs initial cost as the percent of energy from PG&E decreases. Effectiveness is measured by the percent of energy coming from Cal Poly renewable sources with aim that it is over 90%. FM&D is responsible for planning and implementation of a microgrid.

RE Strategy 1.2.2. Install a microgrid on campus.

Phasing: Mid
Sector Overlap: Building
Co-Benefits: Financial, Educational, Campus Climate

Once installed, annual GHG reductions are large to begin with but decrease over time due to State of California Renewable Portfolio Standard. Due to financial and other constraints, the microgrid is unlikely to be installed until after 2020.

RE Goal 2. Implement renewable energy practices on both campus land and buildings
Cal Poly has the resources to become a renewable energy leader. While practices outlined in the Sustainability Report (2014) and the Cal Poly SEP Draft Report (2014) have been successful, they are not aggressive enough to meet the Net Zero target. The following objectives outline steps to be taken to expedite the expansion of Cal Poly's renewable energy system.

RE Objective 2.1. Increase implementation of solar energy panels on existing infrastructure.
This objective is achieved when appropriate university infrastructure is outfitted with solar energy panels. The buildings and other structures suitable for solar panels are easily identifiable and the installation can occur in a timely manner. Numerous campuses across California already have installed this energy source, as an easily attainable opportunity and priority.

RE Strategy 2.1.1. Outfit parking structures with solar arrays on the top level.

Phasing: Near
Sector Overlap: Building
Co-Benefits: Educational, Campus Climate

Cal Poly has recently built three large parking structures with top floors that are consistently in the sun. The Cal Poly Draft Master Plan Update committee has also indicated construction of two more parking structures in the future. All five parking structures are potential platforms for solar panels, from which the campus can produce energy to offset nonrenewable energy use.

RE Strategy 2.1.2. Research the feasibility of solar panels on existing buildings.

Phasing: Near
Sector Overlap: Building,
Co-Benefits: Educational, Campus Climate

Cal Poly's buildings offer rooftops exposed to over 300 days of sunshine per year, which are an excellent opportunity for the utilization of solar panels. Analyzing the buildings best situated for solar arrays is the first step to utilize this existing resource. The buildings that should be analyzed include, but are not limited to: Kennedy Library (35), Architecture and Environmental Design (5), Cotchett Education Building (2), Business (3), Construction Innovations Center (186), Recreation Center (43), H.P. Davidson Music Center (45), Warren J. Baker Center for Science and Mathematics (180), Administration (1), and the College of Engineering campus.

RE Strategy 2.1.3. Install rooftop solar arrays on identified buildings.

Phasing: Near
Sector Overlap: Building, Campus Life
Co-Benefits: Educational, Campus Climate

The installation of solar panels on the Cal Poly buildings identified as part of RE 2.1.2 is the next step in utilizing existing resources to produce renewable energy. An example of a successful installation exists on Engineering West (21). As discussed in Strategy 2.1.1, solar panels require a large upfront investment for the university with a relatively short payback period (SunRun, 2015).

RE Objective 2.2 Build renewable energy infrastructure on campus-owned land.
This objective aims to increase the rate at which renewable energy infrastructure is constructed on campus-owned land.

RE Strategy 2.2.1 Maximize the solar energy implementation effort to ensure a 5MW array.

Phasing: Near
Sector Overlap: Agriculture, Building, Campus Life, PPP, Solid Waste, Transportation, Water
Co-Benefits: Educational, Campus Climate

Cal Poly is a prime candidate for a successful large-scale solar energy installation. The RFP for a 5MW solar array on university land has been issued, however the success of this effort is not assured until physical installation begins. Because the process on this specific project is already in motion it is a near-term effort. However, given the expanse of Cal Poly land holdings, the university should not stop at 5MW; the solar energy effort should continue to expand into the future. Feasibility is a consideration: based upon the current going rate for solar panels ($15,000-$29,000 for 4kW-8kW), the implementation effort of the 5MW system alone is a large upfront investment for the university (SunRun 2015). However, it must be noted that based on feedback ascertained from the large outreach event, respondents indicated reasonable amounts of support for an increase in student fees to help fund this effort.

RE Strategy 2.2.2. Implement the Cal Poly Wind Farm

Phasing: Mid to Long
Sector Overlap: Agriculture, Building, Campus Life, PPP, Solid Waste, Transportation, Water
Co-Benefits: Educational, Campus Climate

Given Cal Poly's climate and 6000 acres of land, wind power is an attainable and effective way to become a renewable energy leader. Chinook Wind has been contracted to complete a year-long study that determines the optimum location for wind generation. The study indicates potential wind power at two different wind energy generation amounts: 300kW vs 1.5MW (D. Elliot, personal communication, February 10, 2016). Near-term, Chinook Wind completes the study and the data can be used to evaluate feasibility, design the project, and identify a developer. In the following years, the construction of the wind farm can take place. Upon completion, the effectiveness would be quantified by the decreased non-renewable energy usage compared to the greater output of renewable energy usage. Note that this is an evolving strategy and therefore needs continued research.

RE Strategy 2.2.3. Research and support new energy storage strategies

Phasing: Mid
Sector Overlap: Agriculture, Building, Campus Life, PPP, Solid Waste, Transportation, Water
Co-Benefits: Educational, Campus Climate

Renewable energy is only as reliable as the sun or the wind. Storage technologies are improving at a steady rate and declining in price. Renewable energy storage (batteries) is often a component of microgrid systems, but can be pursued independently. Cal Poly's population drops by half at the end of each school day and by an even greater amount during the summer. These changes make large swings in the energy demand of campus, which do not always match peak output from renewable sources. To make best use of energy generated on campus, it is critical to develop the ability to store it. As a leading engineering school, Cal Poly is well-positioned to research and test battery technology.

RE Goal 3. A campus with educational practices that promote utilization and production of renewable energy sources

Cal Poly has a constantly refreshed supply of students to provide new ideas and resolve new problems. Outreach efforts show that students and faculty have ideas for how campus can improve. This goal seeks to develop exchange and collaboration between the academic excellence at Cal Poly and the operation of campus.

RE Objective 3.1. Pursue new renewable energy technology as part of academic curriculum

Innovation is necessary to achieve the goals of carbon neutrality and Net Zero energy usage. By teaching students about alternative forms of energy, they are prepared for the changing job market and may even create new industries with their new ideas. More courses and programs being created is the indicator that this objective has been achieved.

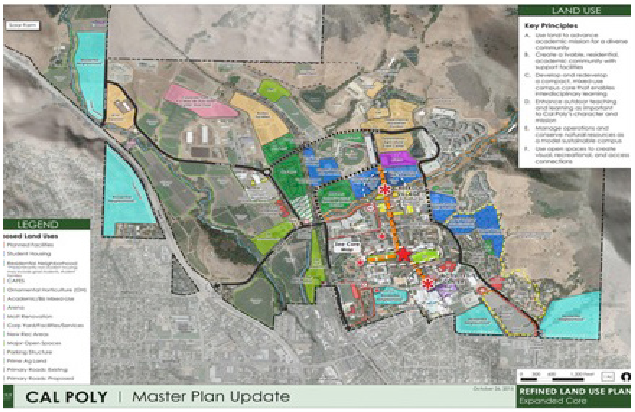
RE Strategy 3.1.1 Expand curriculum related to renewable energy generation and storage

Phasing: Mid
Sector Overlap: Building, Campus Life, PPP, Transportation
Co-Benefits: Educational, Financial

Times that renewable energy produces electricity does not always coincide with usage patterns, making the ability to store energy critical. Reduced reliance on fossil fuels requires cheaper and more energy dense batteries. Curriculum focused on this subject prepares students for the world in which they will work after graduation, but potentially invites them to innovate on campus during their time as a student. The class also serves to improve student and community perspectives regarding renewable energy.

PPP

The Public-Private Partnership (PPP) sector is a standalone. A public private partnership is typically a long term arrangement between a public entity, Cal Poly in this case, and private entity where some of the service obligations of the public sector are provided by the private sector. The focus for Cal Poly is development of a PPP for the provision of faculty and staff housing on campus land. There are several different forms that these arrangements can take. The focus of this sector of the PolyCAP is on the characteristics of the buildings, not the agreements developed to construct and finance them.



The PolyCAP measures found in the PPP inform the development plans for four proposed faculty and staff housing projects. As of 2014, there were 2,811 faculty and staff employed at Cal Poly. Faculty and staff live outside campus, in surrounding communities. Cal Poly is located in the City San Luis Obispo, which is widely viewed as one of the least affordable locations in the US (Cuddy, 2016). As a result, many faculty and staff commute long distances in order to locate lower cost housing.

President Armstrong recognizes the need for faculty and staff workforce housing on or near campus. To address the issue, four sites have been proposed as workforce housing. The first site to be built for faculty and staff housing is located at the intersection of Grand Ave. and Slack St. on the northeast edge of campus. This development would provide 420 units. The three other sites, still in the conceptual stages, are H-8, H-9, and "The Track."

To reduce campus related GHG emissions, the PPP sector focuses on sustainable building and operational practices for the new workforce housing developments, working to reduce the overall GHG

Identity	Name	GHG (MTCO2e)
PPP Goal 1	**Sustainable New Development**	
PPP Objective 1.1	*Reduce the need for commuting to the Cal Poly Campus by 2050.*	
PPP Strategy 1.1.1	Establish workforce housing for Cal Poly faculty and staff at the Slack/Grand site.	427
PPP Strategy 1.1.2	Provide a variety of housing options for faculty and staff on sites H-8, H-9, and Track site.	479
PPP Goal 2	**Energy efficient buildings**	
PPP Objective 2.1	*Establish Net Zero structures.*	
PPP Strategy 2.1.1	Incorporate the use of photovoltaic (PV) systems.	262
PPP Objective 2.2	*Exceed Title 24 energy efficiency requirements by 20%.*	
PPP Strategy 2.2.1	Orient workforce housing buildings to maximize passive cooling and housing.	N/A
PPP Objective 2.3	*Increase the efficiency of building use by 25%.*	
PPP Strategy 2.3.1	Educate residents on efficient energy usage in an interactive manner.	N/A
PPP Strategy 2.3.2	Require energy efficient appliances.	N/A
PPP Goal 3	**Adapt to climate change impacts**	
PPP Objective 3.1	*Design energy-efficient buildings to foster resilience.*	
PPP Strategy 3.1.1	Optimize occupant comfort and building livability.	N/A

emissions associated with the new housing. With four sites proposed to be built, it is crucial to implement strategies that reduce emissions, but also adapt to the changing climate. The goals, objectives, and strategies are intended to guide the development of faculty and staff workforce housing toward a more sustainable and adaptive future.

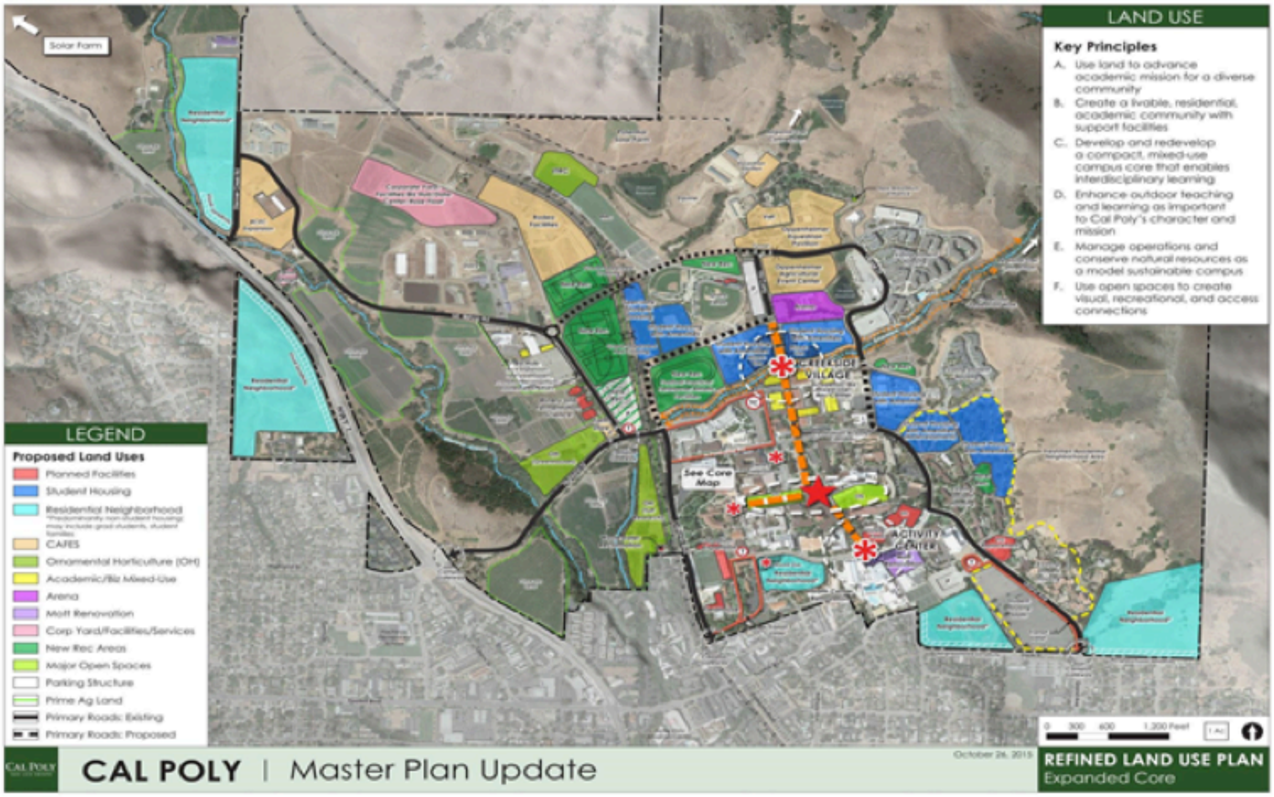


Figure PPP1: Depicts Cal Poly Faculty and Staff Housing options in light blue.

Outreach

The PPP Team participated in campus wide outreach events as part of the PolyCAP process to better understand which strategies students perceived as best suited for the University. The PPP Team found that a large portion of the participants commented that it was important to have Net Zero structures and operations in all new development by 2040. This information enabled PPP to shape its goals, objectives, and strategies.

The PPP Team met with Dennis Elliot to discuss the current and future needs of how Cal Poly is addressing its public private partnership for faculty and staff workforce housing. He indicated that Cal Poly is exploring public private partnerships to create an alternative source of revenue for the University, while adopting practices that reduce GHG emissions. The collaboration with Dennis Elliot provided valuable information, allowing the PPP Team to shape the goals, objectives, and strategies to be put into action for the new development of faculty and staff housing.

Strategies

PPP Goal 1. Sustainable New Development

PPP Objective 1.1. Reduce the need for commuting to the Cal Poly Campus by 2050.

The California Polytechnic State University Greenhouse Gas Inventory states that over half of all campus GHG emissions result from faculty and staff commuting to and from campus, in which accounting for 68% of transportation GHG emissions. To achieve a reduction by 2050, strategic policy implementation must be set.

PPP Strategy 1.1.1. Establish workforce housing for Cal Poly faculty and staff at Slack/Grand site.

Phasing: Near
Sector Overlap: N/A
Co-Benefits: N/A

Currently, Cal Poly provides faculty and staff housing at Bella Montana. Bella Montana occupies a 5.3-acre lot with 69 homes, which are located on the northwest corner of Highland Drive and Santa Rosa. Bella Montana accommodates 69 faculty and staff families, leaving the remaining 2,742 faculty and staff to look for other housing options. Offering 420 additional affordable multifamily units to faculty and staff through the Slack/Grand development helps to reduce the number of commute trips to campus, reducing the campus' overall GHG emissions.

PPP Strategy 1.1.2 Provide a variety of housing options for faculty and staff on sites H-8, H-9, and the Track site.

Phasing: Long
Sector Overlap: N/A
Co-Benefits: N/A

Considering the expensive home prices in the City of San Luis Obispo, Cal Poly can work to provide faculty and staff affordable housing options. Development of sites H-9, H-8, and "The Track" for future housing allows Cal Poly to offer a variety of housing options. Variations in home size aims to attract faculty and staff with varying family types and sizes.

PPP Goal 2. Energy Efficient Buildings

PPP Objective 2.1. Establish Net Zero structures.

In the State of California, all new residential buildings are required to be Net Zero by 2020. All faculty and staff housing is to constructed Net Zero, meaning it generates as much energy as it consumes. This objective not only meets state expectations, but it also supports the campus goals for reduced emissions and whole campus Net Zero by 2050.

PPP Strategy 2.1.1. Incorporate the use of photovoltaic (PV) systems.

Phasing: Mid
Sector Overlap: Building, Renewable Energy
Co-Benefits: Financial, Environmental

Meeting the Objective PPP 2.1 requires that energy is generated on site. Providing PV systems on the rooftops of the development takes advantage of under-utilized roof area and provides energy to support operation of the housing units.

PPP Objective 2.2. Exceed Title 24 energy efficiency requirements by 20%.

Currently, CSU Executive Order 987 requires all "new construction projects shall at a minimum outperform the 2005 Title 24 Standards by at least 15%" (Executive Order 987, 2006, p.5). Combined with the aggressive CSU target of 80% below 1990 GHG levels by 2040, these directives guide the adoption of a target that will support Cal Poly's aim to be a leader in efficiency. The workforce housing development aims to exceed Title 24 by 20%, which is 5% higher than the CSU and surrounding jurisdictions targets.

PPP Strategy 2.2.1. Orient workforce housing buildings to maximize passive cooling and heating.

Phasing: Mid
Sector Overlap: Building, Renewable Energy
Co-Benefits: Financial, Environmental

The workforce housing must take advantage of the existing conditions on campus. Taking the site characteristics into consideration prior to development reduces a building's heating requirement, lessens energy costs, and decreases overall GHG emissions. This strategy focuses on the environmental characteristics surrounding the project sites. Appropriately orienting buildings to the site influences the amount of passive cooling and heating by taking advantage of prevailing winds and sun exposure. These factors allow for design of year-round temperatures and overall comfort.

PPP Objective 2.3. Increase the efficiency of building use by 25%.

Energy efficient buildings often do not perform at expected levels unless inhabitants understand how to make best use of the structure. To make the workforce housing development more efficient, each resident is to be made aware of ways to best use their appliances through interactive programs that foster the efficient use of energy.

PPP Strategy 2.3.1. Educate residents on efficient energy usage in an interactive manner.

Phasing: Mid
Sector Overlap: Building, Renewable Energy, Campus Life
Co-Benefits: Financial, Environmental, Educational, Community Cohesion

Programs developed for Cal Poly student housing to teach students about responsible, efficient energy use are adapted for faculty and staff housing residents, with particular focus on renewable energy and efficient home energy use. The proposed development incorporates similar amenities as the those proposed for the campus core, including solar and bicycle powered charging stations, educational programs, and signs to inform them of alternative energy sources utilized within the housing development.

PPP Strategy 2.3.2. Require energy efficient appliances.

A significant amount of the energy consumed in a household goes to powering appliances. Appliances, including clothing dryers, HVAC systems, dishwashers, and refrigerators constantly use energy and account for the largest portion of a housing unit's energy use.

Phasing: Mid
Sector Overlap: Building
Co-Benefits: Financial, Environmental

PPP Goal 3. Adapt to climate change impacts

PPP Objective 3.1. Design energy-efficient buildings to foster climate resilience.

Climate change impacts, including increased average temperature and heat waves, pose threats to public health and create higher demands for air conditioning. Efficient homes that maintain indoor temperatures and generate renewable energy meet both the health and safety needs of residents and the increased energy needs of the structure.

PPP Strategy 3.1.1 Optimize occupant comfort and building livability.

Phasing: Near
Sector Overlap: N/A
Co-Benefits: N/A

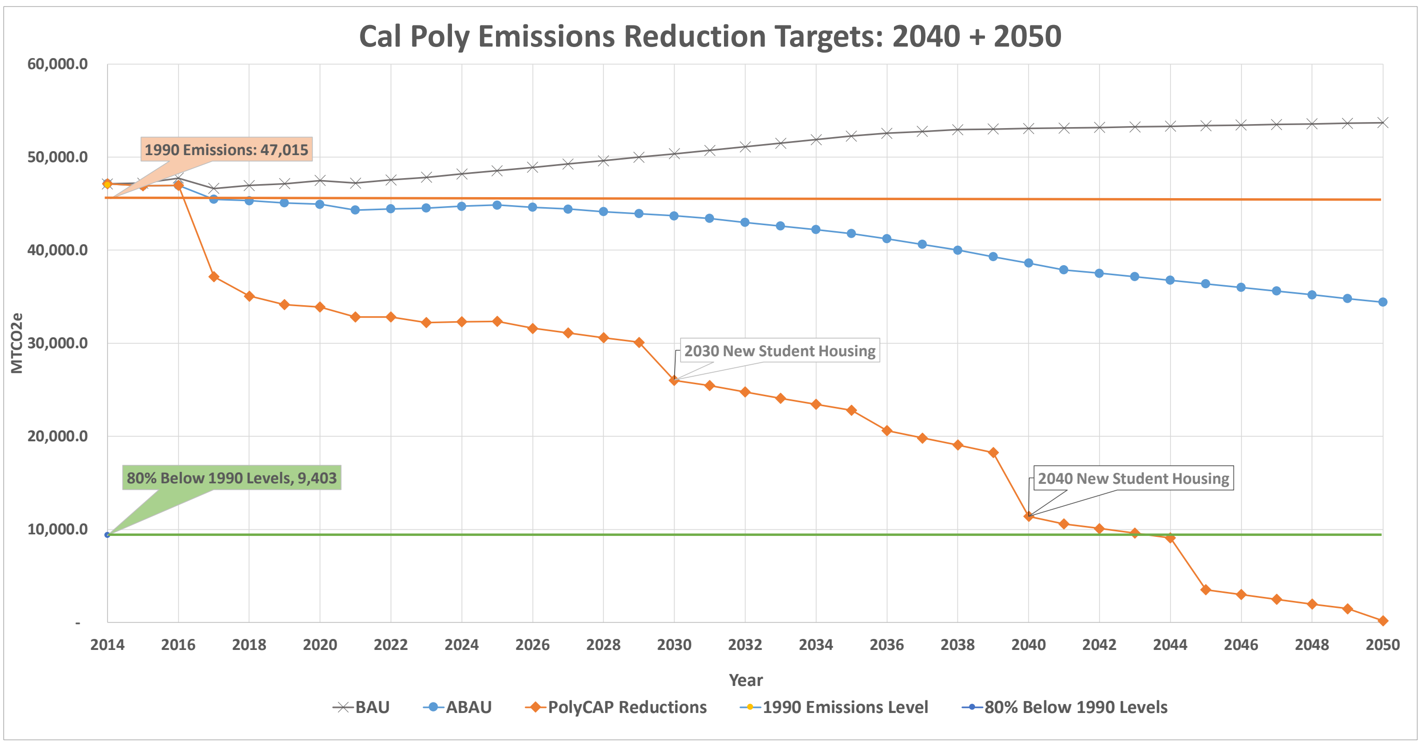
Considering that climate change does have a significant impact on temperature, the use of proper building materials can be an effective measure to reduce the use of conventional energy for heating and cooling on Cal Poly's new workforce housing development. Insulation is an easy and effective means of reducing energy demand. Air infiltration can increase the home heating and cooling costs. Reducing air infiltration can be completed by sealing gaps in windows, doors or any hole where air may enter the home. Reducing energy demand for heating and cooling in the household can save homeowner's money and increases the home's resilience to heat events.

Conclusion & Next Steps

Next Steps

The targets set by the CSU, 80% under 1990 emissions levels by 2040, and Cal Poly's goal of climate neutrality by 2050 demand dramatic change over the next several decades in terms of the manner in which Cal Poly builds, operates, and functions as a University. The PolyCAP presents a series of measures that allow Cal Poly to reach the targets that have been set, both in terms of GHG emissions reduction and resilience to projected climate change impacts.

The strategies in the PolyCAP are loosely categorized into near- (less than 5 years), mid- (5 to 15 years), and long-term (greater than 15 years). The graph below was generated from the GHG emissions Dashboard that accompanies the PolyCAP. This dashboard anticipates a potential phasing program for all PolyCAP strategies to evaluate whether or not the PolyCAP has the potential to reach Cal Poly's adopted targets. In addition to providing an initial evaluation of the PolyCAP's ability to reach targets, the Dashboard also allows progress to be tracked through time. It is up to FM&D, along with all potential collaborators, to add specificity to the proposed measures and implement them well into the future.



Implementation is an ongoing process where a community demonstrates its commitment to addressing climate change, GHG reduction and adaptation. Reaching a goal of 80% GHG emissions reduction in 24 years and Net Zero in 34 years requires much more than improving the efficiency of the same activities or procedures that characterize campus today. These goals demand not only executing current practices at a higher level, but also asks that Cal Poly look for new ways to meet its institutional and educational goals.

Implementation

The PolyCAP was written by current Cal Poly students. The students brought energy, passion, and rigor to the planning effort, but did not bring experience in managing an institution like Cal Poly. As a result, the measures included in the PolyCAP, while informed by feedback from the entities envisioned to implement them, lack detail. Each strategy requires detailed scoping, budgeting, and specific planning. The plan is intended to provide a comprehensive approach to achieve campus climate goals. It does not determine the specifics of individual strategy implementation.

FM&D, in collaboration with the many other departments or offices that contributed to the PolyCAP and are hoped to be collaborators in its implementation, must first prioritize the PolyCAP measures based on mutually agreed upon criteria such as fiscal and political feasibility, anticipated time of implementation, level of preparation necessary to begin implementation, and GHG or adaptation outcome. This evaluation yields a phased, prioritized list of actions built from the PolyCAP. Each measure in the PolyCAP must be implemented by a particular department or office. These entities must carefully consider the strategies they are responsible for implementing and commit to ongoing implementation and monitoring.

Monitoring

Climate change is dynamic with new scientific assessment being released regularly. In addition, our ability to address the challenges presented by climate change also continues to be dynamic with the climate change challenge motivating innovation. Monitoring allows for effectiveness of strategies from the PolyCAP to be evaluated and for assessment of whether or not the measures being implemented are doing enough to reduce emissions and adapt to climate change. Tracking progress can also reveal progress made through unanticipated technological advancement such as battery technology or higher efficiency PV panels.

Each strategy implemented from the PolyCAP must have an indicator or set of indicators that allow for effectiveness to be tracked. In some cases, one monitoring effort can reveal the effectiveness of several strategies. For example, the travel survey used to develop the GHG Emissions Inventory should be repeated every two years. This will allow for the effectiveness of measures focused on reducing reliance on vehicular traffic. Just as critical as collecting the data, a responsible person or office must be identified to review and report on PolyCAP implementation progress. This allows areas of success to be identified, celebrated, and bolstered, and areas with inadequate progress to be evaluated and addressed.

Revision and Update

The Second Nature Cliamte Commitment requires annual evaluation and reporting of progress including updates to the PolyCAP, GHG inventory, and vulnerability assessment. The PolyCAP must be revised and resubmitted every five years. While monitoring data must be collected on an ongoing basis, the measures presented in a PolyCAP require review and revision. Cal Poly will continue to evolve in coming years and different needs or opportunities will emerge. This new context should be accounted for in a PolyCAP.

Appendix A: Strategy Explanation

Part 1: GHG calculations

For all emissions calculations, reductions are based on the emissions data from the Cal Poly GHG Inventory. All reductions are in $MTCO_2e$. Strategies that do not result in a reduction in GHG emissions are listed as not applicable (N/A). Accompanying this document is an excel spreadsheet titled "PolyCAP Dashboard" that lays out all assumptions, calculations, and allows for tracking change through time.

Strategy 1.1.1 Require all new and retrofitted buildings to exceed Title 24 standards by 30% or meet LEED Platinum certification requirements.

According to a USGBC study by Frankel (2008), gold-platinum buildings can use up to 75% less energy on average. Behavioral and monitoring changes are necessary to achieve the highest possible level of efficiency, and thus a 50% reduction in energy use is assumed for this strategy alone. The following GHG reductions are expected with implementation of this strategy:

- 2030: 157.82 MTCO2e
- 2040: 273.21 MTCO2e

BDG Strategy 1.1.2 Orient and mass new buildings to maximize passive cooling and heating.

Orienting new buildings in regards to passive solar design maximizes passive cooling and heating opportunities throughout campus. Orientation strategies take advantage of the sun and wind patterns to reduce building energy use. Passive solar heating and cooling strategies make use of the building components to collect, store, and distribute the gains to reduce the demand for space heating and cooling. A passive system does not require the use of mechanical equipment like air conditioning or heaters, because the heating and cooling flow happens through natural methods, such as radiation convection, conductance, and the thermal storage in the structure itself. According to Fosdick (2012), an aggressive passive solar-heated building reduces heating energy use by 25% to 75% compared to a typical structure. The reduction quantification below assumes an average energy use reduction of 50%. Meters and meter dashboards that display the remaining energy usage throughout buildings for heating and cooling purposes collect related data. FM&D records and monitors this data.

- 2030: 19.77 MTCO2e
- 2040: 42.74 MTCO2e

BDG Strategy 1.1.3 Require all new and retrofitted buildings to use electric appliances only.

All new and retrofitted buildings will use only electric appliances, therefore reducing natural gas consumption 100% from business-as-usual. The following calculation assumes that natural gas consumption is replaced by electricity consumption. The reductions are calculated by subtracting the MTCO2e from electricity consumption to that of therms in the buildings replaced or retrofitted.

BDG Strategy 1.2.1 Implement comprehensive metering in all new and retrofitted buildings, as well as buildings not slated for replacement or retrofitting before 2040.

N/A

BDG Strategy 1.2.2 Increase and educate staff to operate and monitor buildings efficiently.

N/A

BDG Strategy 1.2.4 Replace standard electrical switches with automatic sensor energy appliances (i.e. light switches, automatic computer shut-off).

Data are not available to calculate the reductions from this strategy, because it is unknown which switches need to be replaced in each building. If those data become available, Atkinson (2011) estimates a 25% reduction in energy use from controlled lighting.

BDG Strategy 1.2.5 Disable water heating for restroom faucets in all non-housing buildings

Data are not available to calculate this reduction, as the restroom faucets are not metered separately.

BDG Strategy 1.2.6. Require all departments to complete the Sustainability Mentor Program with PowerSave Campus.

N/A

BDG Strategy 1.2.7. Require departments to pay an overage charge for exceeding a set threshold of energy usage.

N/A

BDG Strategy 1.3.1 Require all new and retrofitted buildings to include rooftop solar panels with the largest feasible array.

To avoid double-counting, this calculation is in the RE section.

BDG Strategy 1.3.2 Require all buildings to offset emissions from natural gas consumption.

According to the EPA (1998) approximately .0076 MTCO2e is offset by one 15-year old hardwood tree. If Cal Poly plants 843 trees on campus land by 2025, those trees will sequester approximately 6.46 MTCO2e in 2040. It is not feasible to plant enough trees to offset al.l emissions from natural gas consumption, so offsets will be purchased until all buildings are replaced/retrofitted and/or alternatives for those operations reliant on natural gas become available.

With the development of new large-scale PV systems on campus, these offsets may come through the sale of renewable energy back to the grid, effectively offsetting the sale of energy from fossil fuel based sources. The remainder of emissions from natural gas usage will be offset by purchasing 100% renewable energy credits from an energy utility.

BDG Strategy 1.3.3 Produce enough energy to meet remaining demand from buildings not slated for replacement or retrofitting

To avoid double-counting, this calculation is in the RE section.

BDG Strategy 2.1.1 Replace all new/retrofitted building windows for double-glazed with low-emissivity coating (or similar), operable windows to reduce amount of hot/ cool air loss.

Cooling and heating systems are associated with high energy consumption. Double-glazed windows consist of two layers of glass with a layer of inert gas in between them. The airtight construction of double-glazed windows creates thermal insulation, therefore reducing solar heat gain by up to 75%, thus, decreasing cooling loads (Levine, M. & Urge-Vorsatz, D. 2007). A study done by TNO for Glass in Europe, concluded that between 15 and 80 million tons of CO2 emissions annually can be saved by 2020 by optimal use of solar control glass (NSG, 2016). According to the Pacific Northwest National Laboratory, buildings with double-glazed and low emissivity windows exhibit an average of 12% reduction in energy use. As a part of strategy 1.1.1.1, all new and retrofitted buildings on campus are expected to include double-glazed windows and low-emissivity coating. FM&D is responsible for collecting data, regarding energy usage reductions after window replacement.

Note: This calculation is assumed in Strategy 1.1.1.

Agriculture

AG Strategy 1.1.1 Assess anaerobic digester feasibility.
N/A

AG Strategy 1.1.2 Implement an anaerobic digester.
Data from the Cal Poly GHG Inventory establishes that waste lagoons emit approximately 234.41 MTCO2e per year. The GHG reduction will be achieved when the anaerobic digester is fully installed. Once the size and type of anaerobic digester has been assessed for feasibility, this emissions calculations must be updated to calculate the emissions produced from combustion of gases for electricity production using the digester.

Dairy Science Departments. Pasadena, CA: Nettie R. Drake.

AG Strategy 1.2.1 Track fertilizer in all programs.
N/A

AG Strategy 1.2.2 Share the data from fertilizer use tracking systems.
N/A

AG Strategy 1.3.1 Utilize sequestration via sustainable range management.
This strategy works to quantify the carbon sequestration potential and implement sustainable range management to increase carbon sequestration on Cal Poly rangeland. Based on the type of rangeland and the soils present at the sight chosen for the strategy the carbon sequestration rate will vary widely. Consulting with relevant literature (Silver et al. 2010, IPCC 2010) a carbon sequester rate of 8 metric tons are sequestered annually for every hectare managed. Considering research regarding carbon sequestration will likely advance in the coming years, this GHG reduction quantification will be recalculated when the justifiable sequestration rates have been established and utilized throughout California.

AG Strategy 1.3.2 Track each individual animal.
N/A

AG Strategy 1.3.3 Changing dairy cow diets.
Citing conversations with Aaron Lazanoff, the Beef Operations Manager, it was determined that only the diets of the dairy cows have the potential to be changed. As shown in the Cal Poly GHG Inventory, dairy cows emit 586 MTCO2e per year. Assuming the most conservative reduction of 5%, this would result in a reduction of 29.3 MTCO2e per year. This strategy has achieved reduction when a full dietary change is implemented, projected for the year 2018.

AG Strategy 2.1.1 Develop a CAFES/Animal Science/Agriculture Operations livestock adaptation plan
N/A

AG Strategy 2.1.2 Invest in livestock resilient to climate change.

Switching to an alternative cattle species is a primarily adaptive measure, however there may be a small decrease in emissions. Criollo cows require less space and less water (USDA). This reduces the natural resources that are required to raise the cattle. A smaller land area for livestock results in a 5% reduction or less in methane (Havlik, et al. 2013), according to a study published by Proceedings of the National Academy of Sciences of the United States of America (PNAS). The study was examining "livestock system transitions" on a global level. Considering Cal Poly is already using a fairly progressive system, there is small opportunity for larger decreases. In order to achieve a reduction, this strategy assumes that all grazing cattle are replaced with a climate resilient breed and achieve a 5% reduction in enteric fermentation rates, yielding a reduction result of 18.22 MTCO2e. The phasing of this strategy is not firmly established but assumed currently for 2022

Transportation

TRN Strategy 1.1.1. Increase the number of housing units for students on campus (CL Objective 1.3) and eliminate residential parking permits for freshman and sophomores living on campus.

The 2035 Cal Poly Master plan includes the goal of housing 65% of undergraduate students on campus by 2035. (See CL objective 1.3 for full set of assumptions and strategy phasing.

TRN Strategy 1.1.2. Create a 1.5-mile radius from the campus core where students cannot purchase general parking permits.

The transportation survey indicates that approximately 24% of students drive alone to campus. It is assumed that 15% live within 1.5 mile radius although further analysis may reveal a larger or smaller percentage. The strategy, using the assumptions and calculations below, yields an overall reduction of 81,459 VMT from student who commute by automobile within this 1.5 mile radius, resulting in a 25 MTCO2e reduction.

> ***Assumption:*** 15% of students live within 1.5-mile radius of campus based on the Cal Poly 2015 Travel Survey
> ***Notes:*** Need GIS Data with nearest cross street to calculate more accurate % of students living within 1.5-mile radius
>
> ***Calculation***: (Student population * % who live within 1.5-mile radius (15%)* (% who drive alone to campus (24%))*(average commute length (1.5 mile) *2 time a day*days of school year (260)

TRN Strategy 1.1.3. Establish a climate impact charge for each parking permit issued.

Academic research, as well as the California Air Pollution Control Officers Association, have shown that various increases in parking prices can have a significant effect on peoples choice to use a personal automobile for commute trips. This strategy establishes a 90% increase in the parking fees with a percentage of this revenue dedicated toward future climate action programs. The strategy works to capture commute trips from students, faculty and staff. Once fully implemented, the strategy will reduce approximately 2,010 MTCO2e of transportation related emissions.

> ***Assumptions:*** "The price elasticity of vehicle trips with respect to parking price is typically – 0.1 to –0.3 (a 10% increase in parking fees reduces vehicle trips by 1 - 3%), depending on conditions (Vaca and Kuzmyak, 2005; Litman 2008)." - Parking Pricing Implementation Guidelines - Victoria Transport Policy Institute - http://www.vtpi.org/parkpricing.pdf
>
> ***Calculations:*** For these calculations it is assumed that a 15% increase in parking fees will reduce vehicle trips by 3%. The strategy currently suggests a 90% increase in parking fees for the Climate Impact Fee, resulting in an 18% trip reduction.

TRN Strategy 1.1.4. Create a comprehensive carpool program for students, faculty, and staff.

The average daily automobile commute trip to campus is 17.4 miles with 305.9 gCO2e emitted per mile per personal automobile (FM&D, 2015). The strategy assumes two trips per day per automobile and two people per car under the carpool strategy implementation. Cornell University has a successful campus-wide carpool program. By increasing parking pricing, Cornell was able to incentivize carpool and found the average occupancy to be 2.2 per vehicle (EPA, 2005). Similarly, the California Air Pollution Control Officers Association has created supported quantification methodology for approximating commuter capture rate on new carpool programs. Based on academic literature and documents (CAPCOA Quantification 2014), this strategy assumes a campus-wide carpool participation of 12%. The strategy, when fully implemented will yield a reduction of 2,022 MTCO2e.

> ***Assumptions:*** 12% participation rate of students, faculty and staff in carpool program, switching to primary mode.

TRN Strategy 1.2.1. Increase the frequency and reliability of bus service

There are an additional 68 routes per week with the increase in bus service, which is an additional 95.2 VMT per week and 3141.6 VMT per school year. This equates to a 7.86 MTCOe2 increase with diesel emission g/ mile of 2475.05. Based on research from the Transportation Research Board's Transit Cooperative Research Program, this strategy calculates a 15% capture rate for student commuters. Further research will determine a more refined approximation of the potential increased ridership for each route. This strategy yields a result of 2,300 MTCO2e if implemented in 2017.

> ***Assumptions:*** 5% capture rate of drive alone commuters for extended hours for Route 6a/b
> 15% capture rate for extended hours for all routes (6, 4, 5)
> http://www.tcrponline.org/PDFDocuments/TCRP_RPT_95c10.pdf

TRN Strategy 1.3.1 Educate students, faculty and staff about sustainable transit option

Based on relevant research (Riggs, 2015; Riggs and Kuo, 2015), educational and transportation demand management outreach programs have been showed to have varying levels of effect within campus environments. Based on supportive research, this strategy calculates a 13% diversion rate for commuters to alternative and more sustainable modes of commuting (Walk, Bike, Bus or Carpool). This strategy, when fully implemented by 2020, will create a total reduction of 3,075 MTCO2e.

TRN Strategy 1.3.2 Offer bike vouchers/discounts for students who opt to commute to campus via bicycle.

Many students who walk to class are first or second years who live on campus and would not be eligible for the bike voucher, so this cohort is not included for the purposes of this estimation. Based on a similar program at the University of Louisville, 3% of students would choose to take advantage of the voucher as an alternative to driving. Because of San Luis Obispo's mild climate and physically active culture, it is assumed that Cal Poly's participation rate in the bike voucher program would be approximately 5%. This strategy results in a GHG reduction of 1,160 MTCO2e.

Assumptions: 5% capture rate for both Students and Faculty for bike voucher program

TRN Strategy 1.3.3 Faculty and Staff Employee Parking Incentive Program.

"A 1996 study examined eight employer programs in California, where parking measures have received considerable attention. The study found that, on average, the employers reduced VMT by 12 percent per employee per year as a result of the program" (US, 2015). Supported by relevant research (Riggs, 2015; Heyman and Ariely, 2004), this strategy assumes a rate of 12% reduction in VMT per year for participants. Fully implemented in 2018, this strategy has a reduction of 1,302 MTCO2e.

Assumptions: "the employers reduced VMT by 12% per employee per year as a result of the program" (US, 2015) The calculations for this strategy assume a participation rate of 20% due to strong incentives offered by the strategy.

TRN Strategy 2.1.1 Phase out the existing vehicle fleet as departments begin to rely on car share and car rental programs

The emissions associated with the campus fleet were 790 MTC02e in 2013 based on the GHG inventory (FM&D, 2015). Based on supportive literature (Lovejoy & Handy, 2013) and a long-term strategy solution, this programs would require a 40% reduction of fuel consumption for the campus fleet every 5 years through 2050. This strategy is focused on gasoline fuel consumption as the primary fuel reduction. When implemented in 2050, the strategy will result in a reduction of 420.8 MTCO2e.

TRN Strategy 3.1.1 Carbon offsets for long distance travel.

The current MTCO2e from air travel is 682 MTCO2e for all campus emissions. This strategy helps to reduce the emissions associated with air travel by purchasing emissions offsets for all campus related air travel. This strategy will be fully implemented in the year 2022 with an effective offset reduction of 671 MTCO2e.

Water

WTR Strategy 1.1.1 Remove 40 Acres of Turf from Campus.

Removing 40 acres of landscaped turf on campus reduces both conveyance and treatment costs and the associated GHG emissions. Removing 40 acres of turf would reduce electricity usage for conveyance and treatment of water by 307 MWh annually, which removes 36 MTCO2e of emissions if completed in 2016. Removal and replacement of turf should occur before December 31st, 2020.

WTR Strategy 1.1.2 Install infrastructure for conveying untreated water for landscaping.

Strategy 1.1.1 reduces treated water requirements by 85%, or an equivalent 140 MWh. Replacing infrastructure to provide untreated water for landscaping eliminates the remaining 30 MWh of electricity currently spent on landscaping water treatment. Installation of infrastructure is to be finished by 2020. In total, if accompanied with WTR 1.1.1 this strategy reduces .4 MTCO2e.

WTR Strategy 1.1.3 Plant water efficient landscapes.

Water efficient landscapes composed of native or drought tolerant species contributes to increased soil health, water retention capacity, increased air quality, habitat, and carbon sequestration (California Department of Water, p.1). The San Luis Obispo Climate Action Plan attributes GHG emissions reduction of 90 MTCO2e to water efficient landscapes (San Luis Obispo Community Development Department, 2012, p.36). Landscape irrigation, specifically turf irrigation, account for some of the predominantly utilized water uses on campus, including 33% of the total water use, or 360 acre feet per year. Therefore, this area in particular is a critical part of ongoing water conservation and emergency drought planning. (Elliot et al., 2015, p.11). Converting to landscape plants that lower water use support GHG reductions associated with strategy 1.1.1 and 1.1.2.

WTR Strategy 1.1.4 Create educational water conservation landscapes.

N/A

WTR Strategy 1.2.1 Replace outdated infrastructure resulting in water leakage in agricultural fields.

It is difficult to estimate exact reductions implemented by strategy 1.2.1. Losses are estimated to be high – even with no treatment requirements, agricultural water conveyance generates almost 23% of all water related emissions. The longer old infrastructure is allowed to remain, the more pressing or significant the issue becomes. Replacing 8000’ of water lines substitutes approximately 25% of all agricultural piping. If implemented by 2025, this should increase efficiency by about 25% and result in a reduction of 6 MTCO2e annually, which would be a 51% decrease from 2014 levels.

WTR Strategy 1.3.1 Prepare a water efficiency plan for structures on campus.

Preparation of a plan does not directly reduce GHGs. However, Chancellor White has mandated that the CSUs reduce domestic water consumption by 20% by 2020. An additional reduction of 20% is feasible by 2040 due to removal of outdated structures and renovation of dated water infrastructure such as toilets, sinks, washing machines, etc. A reduction of domestic water use by 20% by 2020 results in an emissions reduction of 21 MTCO2e. With a further 20% reduction in domestic water use by 2040, this will result in an additional reduction in emissions of 5 MTCO2e.

WTR Strategy 2.1.1 Develop and implement a comprehensive Flood Risk Management Plan.

Strategies 2.1.1 and 2.1.2 focus on climate change adaptation, as opposed to direct reduction in campus water usage. As such, GHG emissions are not impacted by these strategies. For a discussion on the savings and benefits of these measures, refer to Appendix B Part 2.

WTR Strategy 2.1.2 Prioritize and implement the strategies and policies of the Flood Risk Management Plan.

Strategies 2.1.1 and 2.1.2 focus on climate change adaptation, as opposed to direct reduction in campus water usage. As such, GHG emissions are not impacted by these strategies. For a discussion on the savings and benefits of these measures, refer to Appendix B.

WTR Strategy 2.2.1 Establish educational outreach initiatives and incentives to encourage personal and institutional water conservation.

The annual Cal Poly dorm energy competition reduces water consumption by an average of 15% (Cal Poly FM&D, 2009, p.6). This program, is an exemplary model for an educational outreach campaign. The 15% reduction in water usage is a feasible target for Strategy 2.2.1. Current domestic water consumption is 81.2 MGs per year, which leads to 329 MWH of power used including conveyance, treatment and disposal treatment. A 15% reduction decreases domestic water usage to 69 MG annually. This 15% decrease in domestic water use results in emissions reduction of 5 MTCO2e.

The program shall be implemented at the start of the 2017-18 academic year, and aim for a 15% reduction in water use in the first year. The long-term emissions goal of the program is to hold water usage at 15% below 2015-16 usage levels.

WTR Strategy 2.2.2 Implement annual water allowances for campus departments, colleges, and other entities, and penalize entities that exceed their allotment.

Water allowances encourage departments and colleges to take "ownership" of their water usage, as well as increase water use awareness. As the University continues to grow, the objective of this strategy is to keep water usage at 2016 levels or below by all departments on campus. This ensures that other strategies are able to create a meaningful impact on campus water use, and establishes a sound baseline to measure water conservation.

WTR Strategy 2.2.3 Improve water fixtures to reduce consumption.
Refer to 1.3.1

WTR Strategy 2.2.4- Pursue water reclamation research and partnership opportunities.
The impact of the expanded use of recycled water is less energy intensive than potable water use (San Luis Obispo Community Development Department, 2012, p. A-10), to reclaim water to be fit for human consumption, requires 175 MWH of electricity annually according to the Cal Poly Greenhouse Gas Inventory. This generates approximately 30 MTCO2e of GHG emissions per year. Additionally, transmittal of this water requires another 35 MWH of electricity, and 6 MTCO2e of emissions annually. Partnering with the WWRF allows Cal Poly to research the GHG emissions associated with purifying wastewater.

Solid Waste

SW Strategy 1.1.1 Create a waste management eduction booth, manned by members of the Zero Waste Club during WOW
N/A

SW Strategy 1.1.2 Require an online course focused on recycling, composting, landfills and their associated effect on climate
N/A

SW Strategy 1.2.1 Extend the Zero Waste Program campus wide
Installation of recycling bins at the red bricks resulted in a 9% increase in diversion from landfills. If Cal Poly implements Zero Waste stations throughout campus and reaches a match of this effect, the University attains a diversion rate of 81.27%. Further installation of these stations brings this diversion rate even closer to 100%. This will result in a 127 MTCO2e reduction.

Calculation: Recycling Bins in Redbricks

Table B-1: Recycling Bins in Redbricks

# Buildings	% Diversion Increased	% of Total Per Building	% Total Diversion
6	9%	0.015	72.27
Match Success Rate	9%	0.015	81.27
37	56% (9% diversion rate increase per 6 buildings)	0.015	56%

MTCO2e Reduction: 127

Estimated # Stations	Estimated Cost Per Station	Estimated Total Cost	
37	$6,000.00	$222,000.00	

SW Strategy 1.2.2 Increase Cal Poly's participation in competitions, such as Recyclemania

Rutgers University won the Gorilla Prize for recycling a total of 222,9611 lbs (1011.33 tons). Data from the Recyclemania competitions supports an average diversion rate of 5% from implementing a similar program. Through this strategy an total reduction of 11.47 MTCO2 will be achieved.

Source: http://recyclemaniacs.org/sites/default/files/2012%20-RM%20Results%20Release%20-%20FINAL.pdf

SW Strategy 1.2.3 Require reusable containers in all dining facilities

With 5,400,000 containers avoided, each with a mass of 0.0434 kg, a total of 234 MT of solid waste is removed. This equates to a reduction of 2.3 MTCO2e.

SW Strategy 1.2.4 Explore using compostable or recyclable materials for all packaging

N/A

SW Strategy 1.3.1 Renegotiate the Coca-Cola Contract

According to numbers supplied by Eric Veium, Campus Dining utilized 312,360 20 oz. soda bottles in 2013/2014. While this strategy does not directly reduce campus GHG emissions, it works towards campus's waste diversion rate goals and reduces campus waste in general. "The manufacture of every ton of PET produces around 3 tons of carbon dioxide (CO2)." (Pacific Institute)

SW Strategy 1.3.2 Install water bottle filling stations

Duke University installed 50 water stations and was able to reduce plastic bottles by 400,000. Both Dennis Elliot and Eric Veium expressed a desire to expand water stations to every floor of every building. According to numbers supplied by Eric Veium, Campus Dining utilized 350,787 water bottles in 2013/2014.

SW Strategy 1.4.1 Provide pickup and transport of food waste to campus anaerobic digestion facility

The GHG reductions of this strategy are in large part a result of the actions of the Agriculture sector. In terms of solid waste, the GHG reductions come from not having to transport food waste off campus. Although not included in the GHG inventory, this strategy would lead to overall waste reduction on campus.

Campus Life

CL Strategy 1.1.1 Expand on-campus grocery options.

Because the data required to calculate GHG reductions for this strategy are not included in the Background Report, reductions are estimated and are not included in this document's total reduction goal. However, with the right data, reductions can be calculated using vehicle trips that would be traveling off campus to go grocery shopping. Placing a grocery store on campus reduces the number of trips to off campus grocery stores. Information required to calculate the GHG emissions reduction includes how many trips per week campus residents take and how far they travel. In the future, success of this strategy is measured by the addition of survey questions in Cal Poly's annual Transportation Survey asking where campus residents travel when leaving campus. Success of this strategy can be measured by comparing the amount of on-campus student trips taken off campus to grocery stores before and after the implementation of this strategy.

CL Strategy 1.1.2 Provide community gardens for university housing facilities.

An indicator of this strategy's success is the number of "plots" rented to students and a reduction in grocery vehicle trips to and from campus measured by Cal Poly's annual Transportation Survey. Because the information needed to track GHG emissions reductions does not yet exist for this strategy, reductions are estimated using data from CL Strategy 1.1.1 numbers and the following assumptions. Approximately 20 students currently use the two existing community gardens on campus (S. Bloom, personal communication, February 19, 2016). Students growing produce are expected to travel less to the grocery store than those students not using community gardens, so it is assumed that each community garden plot reduces that student's trips to the grocery store by half. It is also estimated that the average student makes one trip to the grocery store per week. This strategy reduces this number to 0.5 trips per week. This strategy increases the number of community gardens on campus from two to 20, providing plots for approximately 200 students and reducing the total number of weekly trips to the grocery store, therefore reducing GHG emissions.

CL Strategy 1.1.3 Increase healthy dining options on campus.

By providing a wider variety of healthy dining options and the opportunity to purchase fresh local produce at the on-campus farmer's market, this strategy reduces the amount of vehicle trips off campus for dining purposes. Because the data required to monitor GHG emissions for this strategy are not included in the Background Report, exact reductions cannot be calculated. However, this strategy increases the likelihood of students dining and purchasing produce on campus. Therefore, this reduces GHG emissions from vehicle trips off campus. The success of this strategy can be measured in the future by additional questions focusing on the purpose of trips off campus in the annual Transportation Survey.

CL Strategy 1.2.1 Develop a Poly Canyon Trail map and management plan.

The Poly Canyon Trail plan reduces GHG emissions caused by vehicle trips off campus for outdoor recreational purposes by encouraging the use of on-campus hiking trails. However, because data that is necessary to calculate the exact emissions reduction of this strategy was not included in the Background Report, the following calculations are estimated and information was gathered from several credible sources. In 2012, 14% of young adults from ages 18 to 24 participated in hiking, with the average person hiking 18 times a year (Outdoor Foundation, 2013, p. 37). Considering this information and Cal Poly's future on-campus resident growth, approximately 1,300 campus residents are expected to go hiking 18 times a year, resulting in over 23,000 vehicle trips off campus. The average vehicle trip to popular hiking trails, Bishop Peak and Cerro San Luis Obispo (Madonna Mountain), is two miles from campus making the annual VMT to off-campus hiking almost 37,000. The Poly Canyon Trail map is expected to reduce off-campus hiking by 30%, reducing annual VMT to over 34,000. In order to monitor success of this strategy, the annual Transportation Survey is needed to ask residents the purpose of vehicle trips off campus.

CL Strategy 1.2.2 Expand on-campus nightlife.

This strategy reduces GHG emissions caused by vehicle trips to off-campus entertainment. Because the information necessary to calculate GHG emissions reductions for this strategy is not included in the Background Report, reductions are estimated. Implementation for this strategy occurs in multiple stages, the first being its inclusion in the Master Plan update. Following its inclusion, is a feasibility assessment and implementation plan.

CL Strategy 1.3.1 Provide University Housing surrounding the academic core.

Providing University Housing in the campus core reduces vehicle trips to and from campus, thereby reducing GHG emissions. Therefore, the following reductions are an estimate based off of the 2015 Transportation Survey and other credible sources. According to the 2015 Transportation Survey, 24% of students drive alone to campus. Considering the future growth of Cal Poly's student population, if this trend continues almost an increasing number of students would drive to campus alone. This strategy is expected to break that trend, dramatically reducing the number of students driving to campus and avoiding the increase in GHG emissions. The success of this strategy is measured by a reduction in students driving alone to campus and data obtained from the annual Transportation Survey. Further analysis will determine the cost benefit analysis results of the net MTCO2e reductions from produced commute emissions but additional GHG emissions produced from the increased housing facilities on campus.

The completion of these new housing developments will be completed in two benchmark stages: 45% of students housed on campus by 2030 and 55% of students housed on campus by 2040. The overall commute GHG emissions reductions would be 16,757 MTCO2e in 2040.

CL Strategy 2.1.1 Expand and move Red Brick Energy Competition.

GHG emissions reduction for this strategy can be calculated once building meters are installed in all campus housing facilities. The total yearly savings from energy competition for electricity and water usage is 121,333.3 kWh and 1,038,952 gallons of water, which reduced a total of 53.33 MTCO2e (Green Campus Program, 2016). Since there are 1,478 residents in the Red Brick dorms, the per capita energy use reduction of 82.1 kWh. Because more residents are likely to participate when the competition is moved to the beginning of the academic year, an additional reduction of about 20% is expected, bringing the per capita energy reduction to 98.4. This strategy will reduce 125 MTCO2e if implemented by 2025.

CL Strategy 2.1.2 Promote methods for keeping utility usage 10% less than baseline.

This strategy reduces GHG emissions by helping students to maintain energy conserving habits and preventing sudden increase of energy usage after the energy competitions. In addition to the total yearly energy saving from energy competitions, the strategy intends to increase energy saving by 10%. The 10% of total energy saving from Red Brick Energy Competition is 12,133 kWh, which makes per capita energy savings increase by 8 kWh. In other words, in order to achieve 10% increase in energy saving, each student needs to lower their energy usage by 8 kWh. In 2040, there are approximately 13,750 student residents and 48 residence halls. Therefore, the average number of students per residence hall is 286 students. It is expected that 50% of total residence halls are going to participate in the incentive program because 2015 Red Bricks energy competition shows that three out of six or 50% of residence halls in the Red Brick dorms successfully reduced energy usage by more than 1.5% (Lucid Design Group, 2015). The strategy will reduce associated GHG emissions by 25.5 MTCO2e.

CL Strategy 2.2.1 Host "Sustainability Tours" of campus.

As this strategy is educational, it does not have direct impact on GHG emissions reduction.

CL Strategy 2.2.2 Create interactive renewable energy sources on campus with education components.

Solar and bicycle powered phone charging stations reduce GHG emissions by replacing the carbon emitting energy source with clean energy. The solar powered charging station generates 0.005 Kilowatts per locker (WrightGrid, *n.d.*). There are nine lockers for each stations. With five solar powered charging stations and five hours of daily use, approximately 405 kWh or 0.0546 MTCO2e can be reduced each year starting from 2020, after stations are installed. A bicycle powered energy source generates 1 kWh (Gulland, 2008). With three bicycle powered charging stations and five hours of daily use, 5400 kWh or 0.71 MTCO2e is estimated to be reduced starting from 2020, after stations are installed. The five hours of daily use is assumed for both solar and bicycle powered stations after considering number of hours that students usually spend on campus.

CL Strategy 3.1.1 Expand and develop hazard mitigation related to climate change impacts.

According to the Cal-adapt online tool, the annual temperature in the San Luis Obispo area is expected to rise as high as 5.2 degrees Fahrenheit annually as a result of climate change. Points of sensitivity on the Cal Poly campus that could be impacted include public health, recreation, buildings and agricultural land. Additional impacts of climate change include natural disasters, sea level rise, and extreme heat days.

Although there are no GHG emissions reductions, CP EMP protects and reduces impacts and vulnerability on the campus community and property. However, Safety Officers under the EOC, monitor and check the effectiveness of the plans overtime. Additionally, they check percent reductions of health effects and injuries due to climate change over time.

CL Strategy 3.1.2 Educate the campus community on vulnerabilities caused by climate change.

Instead of reducing GHG emissions, the strategy only reduces the number of people impacted by climate change. Additionally, the Health Center checks and monitors health effects and injuries due to climate change over time after implementation of the strategy. California's Department of Public Health defines that the heat-related hospitalization rate for age group 18-34 is 0.63 per 100,000 populations (2012). This age group is selected because it represents large majority of student populations. The Cal Poly enrollment projection for Fall 2015 is 20,527 (Cal Poly Institutional Research, 2015). Therefore, it is estimated that 2,654 student populations can be negatively impacted by extreme heat. In the same way, with the projected student population of 22,298 in 2025, 3,132 impacted student population is estimated. The Cal Poly health records are needed to further calculate the students visiting the health facilities.

Renewable Energy

RE Strategy 1.1.1 Re-negotiate terms with PG&E.

Indicators of success include a decreased dependence on energy from PG&E and the ability to move energy created on campus into the community. Phasing is estimated to be mid-term. Quantification can be assessed if Cal Poly is able to construct a microgrid legally and can use their own renewable sources.

RE Strategy 1.1.2 Apply for PG&E RES-BCT program.

N/A

RE Strategy 1.2.1 Begin Research and Analysis of microgrid feasibility.

A microgrid used to power a campus similar to the size of Cal Poly is estimated to improve energy efficiency by 7-30% (Redfield). Research, feasibility planning, and installation takes at least a decade or more. Assuming that the microgrid is implemented by 2040 and using an efficiency rate of 20%, about a 10,000 MWh reduction the first year would be achieved. The data to be used to evaluate implementation success is the percentage of energy that Cal Poly uses generates and uses itself. FM&D collects and evaluates data from the substation to assess exactly how much renewable energy is being used along with how much PG&E energy is being used. If the amount of renewable energy used is more than what is used from PG&E, then Net Zero emissions can be achieved.

RE Strategy 2.1.1 Outfit parking structures with top level solar arrays.

This is deemed successful when installation of the solar arrays is constructed on the identified parking structures. The three existing parking structures have the following top level square footages:

The average of these is approximately 60,000 square feet. Therefore, the two additional structures are expected to have approximately 60,000 square feet each. In total, the usable area for solar arrays is therefore 298,400 square feet. Based on this available size, the total array is approximately 3,000 kW, which can produce about 5,000 MWh (NREL, *n.d.*)

- 2040: 227.56 MTCO2e

RE Strategy 2.1.2 Research the feasibility of solar panels on existing buildings

An accurate reduction calculation requires the square footage of the rooftops of new/retrofitted buildings, which is currently unknown. However, it is expected that these buildings will produce at least as much energy as they consume. Annual energy demand for each building in 2040 is approximated based on the implementation of BDG Strategy 1.1.1.

- 2040: 137 MTCO2e

RE Strategy 2.1.3 Install rooftop solar arrays on identified buildings
Buildings not slated for retrofitting or replacement need to be outfitted with solar panels to produce at least 50% of the remaining electricity demand. After implementation of strategies 2.11 and 2.1.2, remaining electricity consumption is about 46,287 MWh by 2040. Successful implementation of this strategy will include solar arrays with system sizes collectively equal to 93.65 MW. A DC system of this size can produce about 25,186 MWh.

- 2040: 982.27 MTCO2e

Strategy 2.2.1 Maximize the solar energy implementation effort to ensure a 5 MW array
This strategy will ensure the creation of a large PV array to cover this remaining demand and work to produce all electricity for campus through this PV array and other renewable energy source. The size of the "array" will produce approximately 26,313 MWh annually and yield a GHG reduction of 1,026.21 MTCO2e if built and utilized by 2040. In addition to this array, the ability to duplicate this process to produce another array of the same size can yield monetary results for the campus and offset the unavoidable emissions from other sectors. This second array will yield the same GHG reduction if built by 2040.

RE Strategy 2.2.2 Implement the Cal Poly wind farm

This is deemed successful when installation of the wind farm/wind turbines begins. While this proves success of the strategy, it does not prove a successful GHG emissions decrease. It is assumed that this is complete by the year 2025, therefore the successful GHG emissions decrease occurs following that year. This rate of decrease is an additional 56.71% as compared to the typical state mandated decrease. This is calculated by assuming Cal Poly's current electrical output (44683.131 MWh) as the base number. In addition to this, it is assumed that five wind turbines can produce 16,425 MWh of energy annually in total. This therefore vastly offsets a portion of Cal Poly's electrical output.

RE Strategy 2.2.3 Research and implement new energy storage strategies.
N/A

RE Strategy 3.1.1 Develop an engineering course about energy generation and storage.
Indicating success for this strategy is different because ideal success relies on a major innovation in energy storage and harvesting technology. Most of the strategy, however, is focused on the development of a new course. This new course is based on education, so it does not have a direct reduction in emissions. This strategy supports Strategy [2.2.3.] (Begin Research and Analysis of microgrid feasibility) & Strategy [1.1.2.] (Increase continued research and implementation progress of the Poly Canyon Wind Farm). The development of a new battery technology makes a campus microgrid more feasible, because surplus energy is then available when there is not enough being produced. The Poly Canyon Wind Farm benefits from a new battery for similar reasons, in addition to the potential research aid the course can provide.

PPP

PPP Strategy 1.1.1 Establish workforce housing for Cal Poly faculty and staff at Slack/Grand site.

This strategy reduces GHG emissions by providing housing to Cal Poly faculty and staff in walking proximity to campus. Providing 420 units to accommodate faculty and staff reduces the number of commutes by encouraging them to live closer to campus and cut out vehicle trips. To calculate the GHG reduction, the California Polytechnic State University Greenhouse Gas Inventory provides the data needed. The GHG emissions reduction use the following data: 420 units for the faculty and staff, 68% account for the percent in commutes, the commute length is 17.4 miles for a round trip of 34.8, and the total commute days is 260. This GHG estimate assumes a two story development with 80% of the roof used for PV.

This strategy utilizes a cost benefit analysis of net GHG emission reductions from reducing commute trips due to faculty/staff commute mode shift and the additional emissions associated with new housing developments, assuming all new housing is at least to LEED Gold building standards. The table below illustrates the net reduction per new resident as well as the total reduction for the 420 occupied units.

Measure	***MTCO2e***
Benefit (MTCO2e/pp)	0.87
For 420 faculty/staff	365

PPP Strategy 1.1.2 Provide a variety of housing options for faculty and staff on sites H-8, H-9, and the Track site.

As mentioned in the California Polytechnic State University Greenhouse Gas Inventory, commute behavior is influenced by campus actions involving housing selection options for faculty and staff. Insufficient housing options within close proximity to campus creates higher commute rates to campus. This strategy reduces GHG emissions by allowing individuals to live closer to campus and utilize other modes of transportation that do not emit GHG emissions. This strategy is calculated by taking the units designated for sites H-8, H-9, and The Track. The CSU Committee on Campus Planning, Building and Grounds states that site H-8 consists of six acres with 72 units, and site H-9 consists of 15 acres with 180 units. Using ArcGIS software the Track site area was calculated at approximately 10 acres. In the City of San Luis Obispo`s Zoning Code, the Track development zone is classified as a R-2 classification. An R-2 zone allows 12 density units per net acre. If the Track site has 10 acres and is allowed 12 density units per net acre, then the track site consists of 120 units. For this strategy, new housing developments are assumed to be 75% more energy efficient for electricity and natural gas than the average multi-family housing development in 2010 (DOE Energy Data Book 2010)

The net GHG reduction benefit of these new developments was calculated using the same methodology as calculations for the Slack/Grand development. The following tables highlight the per person and total reduction benefit of all three sites. See Appendix A for detailed calculations.

H-8 Total Reduction

Benefit (MTCO2e/pp)	***Total MTCO2e Reduction (72 faculty/staff)***
0.8	161

H-9 Total Reduction

Benefit (MTCO2e/pp)	***Total MTCO2e Reduction (180 faculty/staff)***
0.8	241

Track Site Total Reduction

Benefit (MTCO2e/pp)	***Total MTCO2e Reduction (120 faculty/staff)***
0.8	241

PPP Strategy 2.1.1 Incorporate the use of photovoltaic (PV) systems.

The inclusion of PV systems on new workforce housing will help reduce a overall emissions for the new housing units. Combined, the four housing sites will produce 792 units. All housing units are assumed to be two stories tall with 90% of roof space available for a PV system. Energy production for the arrays was calculates using the PVwatts calculator developed by NREL. All PV systems were calculated to be 15% efficient although these calculations may change with increased panel efficiency. Maximizing all four housing units with PV systems would reduce 262 MTCO2e if built by 2035. According to the SLO Tribune, Cal Poly is set to build a workforce housing complex near the Grand Avenue and Slack entrance through a public private partnership. The project is proposed to include approximately 420 multi-family condominium style market-rate value units on a 10-15-acre site (Wilson, 2016). The average size of a new multi-family building completed in the Midwest in 2013 is about 1,076 sq. ft. per unit (U.S. Census, 2016). According to Dennis Elliot, Cal Poly's Facilities Management Director, workforce housing is similar to existing condos in the City of San Luis Obispo as well as other projects in Cal Poly. Therefore, this project is likely to be two stories high, including around 200,000 Sq. Ft. (2.89 Acres) of roof area. Estimating 10% of the roof is used for appliances, plumbing, and access points, solar panels can cover 180,000 sq. ft. Using a medium priced solar panel such as the Suntech-STP1805-24/Ab-1 rated at $4.71/W, in the City of San Luis Obispo, solar panels generate about 3,000 MWh/yr. (NREL, 2015), which is more than what the developments use. The installation of PV produces energy and can avoid emitting 582 MTCO2e. PV solar panels help make buildings more adaptive because roof temperatures can be reduced during warmer days which allows the building to require less energy to cool.

PPP Strategy 2.2.1 Orient Market Rate Housing Buildings to maximize passive cooling and heating.

The increase in temperature increases the demand for energy to power air conditioning units. An alternative to decrease energy use, buildings are to be oriented to capitalize on the site's location to minimize or stop the reliance for external power. Using natural methods such as solar radiation and wind to collect, store, or distribute air and sunlight within the structure allows for passive heating and cooling. According to Judy Fosdick, a passive solar-heated building reduces heating energy use by 25% to 75% compared to a typical structure (Fosdick, 2012). GHG emissions reductions can be quantified once meters are installed in the workforce housing development. Considering the site is located adjacent to existing streets and a moderately sloped topography with vegetation, the estimated reduction of the market rate housing is around 50%.

PPP Strategy 2.3.1 Educate residents on efficient energy usage in an interactive manner.

Interactive renewable energy educational components inform residents on how to efficiently use energy, but not directly decrease GHG emissions. The solar and bicycle powered charging stations reduce GHG emissions as they are alternative sources of power that do not emit GHGs. A solar powered charging station, such as the WrightGrid Model can be incorporated into the project. Each solar powered charging station contains nine lockers, and each locker generates 0.005 Kilowatts (WrightGrid, *n.d.*). Considering the project's size, three charging stations can easily be included within the development.

PPP Strategy 2.3.2 Require energy efficient appliances.

Providing residents with efficient appliances not only increases awareness of efficient energy use, but also a way to save money while reducing GHG emissions. Energy efficient products such as Energy Star labeled appliances were created by the Department of Energy and the Environmental Protection Agency in an effort to reduce pollution and emissions of carbon dioxide by making the public aware (Energy Star, 2016). According to the U.S. Department of Energy, efficient products such Energy Star rated products can reduce energy use from 30 to 50% (USDE., 2015). If the Market Rate Housing development adds energy efficient appliances, approximately 0.39 MTCO2e are saved per year assuming 40% reductions.

PPP Strategy 3.1.1 Optimize the occupant's comfort and the buildings livability.

Options to achieve the best results depend on the type of insulation and the installation. State and local building codes typically include minimum insulation requirements, and methods to meet energy efficient standards. Cal Poly's new residential units can optimize energy efficiency by using the best R-value insulation, a measure of resistance to heat flow through a given thickness of material. According to (Shrinkthatfootprint.com), a well-insulated home is the best way to reduce cost. They provide a visual comparison of heat gains and losses for three different types of insulated homes: a leaky house, which is the least quality, in order to combat the heat and gain loss, the house requires 300 kilowatt hours of energy per square meter per year to remain at a comfortable temperature. The second type, a modern house is the typical new building helps reduce the energy needed to heat the property to 150 kilowatt hours per square meter per year. A third type, a passive house is the most and best insulated property imaginable. All materials used to build a passive house offer good insulation, having triple glazed windows, and so airtight that a ventilation system is needed to keep the air fresh. The passive house estimated to need 15 kilowatt hours per square meter per year, most of which can actually be generated through a heat recovery system in the ventilation system. The difference in heating bills for an average sized home in each class has been estimated to be $1,500 a year for the leaky home, $750 a year for the modern home, and $100 a year for the passive home.

References

References

2015 Results. (2015). Retrieved February 14, 2016, from http://recyclemaniacs.org/2015results

Cal Poly Facility Management & Development (FM&D). (2015). Background Report: Poly Climate Action Plan. Retrieved January 2016, from https://polylearn.calpoly.edu/AY_2015¬2016/pluginfile.php/377643/mod_resource/content/1/Draft

Arakaki, J., Lawrence, P., & Nakamura, A. (2010). Energy Harvesting From Exercise Machines Cal Poly Recreation Center Implementation. Retrieved January 2016, from http://digitalcommons.calpoly.edu/eesp/41/

ASI. "Asi Board of Directors Standing Rules." Standing Rules (2015): n. pag. Web. 20 Jan. 2016. Retrieved on January 20, 2016 from http://www.asi.calpoly.edu/admin/img/upFormsPolicies/1444168380_BOD%202015-16%20Standing%20Rules-FINAL%20BOD%20APPROVED.pdf

ASPA and Public Joint Venture Recycling-Appendix A. (*n.d.*). Retrieved February 14, 2016, from http://www.aspower.com/aspaweb/bids/RFP NO. ASPA14.1216 ASPA AND PUBLIC JOINT VENTURE RECYCLING-Appendix A.pdf

Assistant Grocery Store Manager Salary (United States). (2016, January 12). Retrieved February 27, 2016, from http://www.payscale.com/research/US/Job=Assistant_Grocery_Store_Manager/Salary

Association for the Advancement of Sustainability in Higher Education (AASHE). (2015). 5.6 Design and Construct Only the Greenest, Most Energy Efficient New Buildings. Retrieved January 27, 2016, from http://www.aashe.org/wiki/cool-campus-how-guide-college-and-university-climate-action-planning/56-design-and-construct-on

B&N Enterprises. (2009). Evaluation of data supplied by Animal Science

B&N Enterprises. (Summer 2008). An assessment for the development of an energy audit renewable energy power generation project for the School of Agriculture, Food, and Environmental Sciences, Cal Poly, San Luis Obispo.

Benzine, Craig. (2016). Why We Need A Revolution In Energy Storage. PBS Digital Studios. [Video file]. Retrieved January 2016, from https://www.youtube.com/watch?v=itgiyFc5t-g&list=PLsRLUurFnvvVCTaahveVqQzjFlg7 KdGjZ&index=2

Bergey Wind Power. (2012). Small Wind Turbines for Homes and Businesses. Retrieved January 20, 2016, from http://bergey.com/wind¬school/residential¬wind¬energy¬systems

Biogas Energy. (2015). Biogas Energy. Retrieved from: http://biogas-energy.com

Cal Poly Campus Health and Wellbeing. (2016). Haven and Alcohol Wise programs. Retrieved on 2/16/16 from http://www.hcs.calpoly.edu/pulse/students/alcoholedu-haven

Cal Poly Facility Management and Development. (*n.d.*). Campus Operations. Retrieved January 31, 2016, from https://afd.calpoly.edu/sustainability/campusoperations.asp

Cal Poly Institute Research. (2014). 2015-2016 Cal Poly Enrollment Projections. Retrieved on February 15, 2016, from http://content-calpoly-edu.s3.amazonaws.com/ir/1/images/2015-16%20Enrollment%20Projections_0.pdf

Cal Poly Jobs. (2014).Employment Opportunities. Manager of Emergency Management and Business Continuity. Retrieved on February 29th, 2016 from https://www.calpolyjobs.org/applicants/jsp/shared/position/JobDetails_css.

jsp?postingId=406604
Cal Poly Master Plan & Environmental Impact Report (2001) (Vol. 1). (2001). San Luis Obispo, California: California Polytechnic State University. Retrieved 10/09/15 from https://afd.calpoly.edu/facilities/masterplan/plan/vol1.pdf
Cal Poly University Housing. (2016). Freshmen Housing and Dining Fees/2016-17. Retrieved on February 15, 2016, from http://www.housing.calpoly.edu/content/freshmen-fees-residence-hall-payment-due-dates
Cal Poly, San Luis Obispo. (2014) Quick Facts. Retrieved from http://calpolynews.calpoly.edu/quickfacts.html
Cal Poly, San Luis Obispo. (2014). Cal Poly SEP Draft Report. Retrieved October 16, 2015.
Cal Poly. (2014). Administration and Finance,Student Success Fee Allocation Advisory Committee,FY 2015/16 Student Success Fee Allocations. Retrieved on February 15th, 2016 from https://afd.calpoly.edu/fees/fy%202015_16%20ssf%20allocation%20memo_worksheet.pdf
Cal Poly. (2015). 2014-15 Academic Plan Report: Analysis of Cal Poly's Future Leadership Opportunities and Preliminary Recommendations, Draft Executive Summary.
Cal Poly. (2015). Cal Poly Emergency Management Multi- Hazard Preparedness Plan, Part 1: Basic Plan, Revised June 2015. Retrieved on January 25th, 2016 from https://afd.calpoly.edu/emergency/docs/basic_plan_sec_2015-06-09%20final.pdf
Cal Poly. (2015). Campus Operations. Retrieved on February 15th, 2016, from https://afd.calpoly.edu/sustainability/campusoperations.asp#Life
Cal Poly. (2015). Draft Master Plan Update, September 2015. Retrieved on January 27th, 2016 from http://masterplan.calpoly.edu/wp-content/uploads/2015/09/DRAFT-Edited-MP-Principles-9-15.pdf
California Department of Public Health. (2015). Climate Change Data: Heat-related illness Summary Tables. Retrieved on February 15, 2016, from http://cehtp.org/faq/climate_change/climate_change_data_heat_related_illness_summary_tables#_faq_1_4
California Polytechnic State University. (2014). Drought Response Plan Highlights. Administration and Finance Facilities webpage. Retrieved from https://afd.calpoly.edu/sustainability/drought.asp
California Stormwater Quality Association. (2003). California Stormwater BMP Handbook.
Campbell, E. (2011). Online Journal of Distance Learning Administration, Volume XIV, Number V, Winter 2011. University of West Georgia, Distance Education Center. Retreived on Januaray 31, 2016 from http://www.westga.edu/~distance/ojdla/winter144/campbell_campell144.html
Carswell, Callie. (2014). The Desert-Friendly Cow. High Country News, Fallout. Retrieved from: http://www.hcn.org/issues/46.19/the-desert-friendly-cow
Chargepoint. "Electric Vehicles Charge Ahead on College Campuses with 35% Increase in Charging Stations." Chargepoint, 2014. Web. 20 Jan. 2016. Retrieved on January 20, 2016 from https://na.chargepoint.com/charge_point
City of Boulder & The Sanitas Group, LLC. (2013). City of Boulder Critical Facilities &Mobile Populations Ordinance Cost Analysis. Boulder, CO: City of Boulder.
City of San Luis Obispo, Utilities Department. (December 18, 2014). Water Resource Recovery Facility Draft Facilities Plan. Retrieved 2/10/16 http://www.slocity.org/home/showdocument?id=5841

City of San Luis Obispo. (2012). City of San Luis Obispo Climate Action Plan. Retrieved from: http://www.slocleanair.org/images/cms/upload/files/SLO_CAP_WEb.pdf

City of San Luis Obispo. Zoning Ordinance. (2015).Medium Density residential (R-2) Zone. Retrieved from http://www.slocity.org/home/showdocument?id=5861

Clean Energy Authority. (*n.d.*). California Solar Rebates and Incentives. Retrieved from: http://www.cleanenergyauthority.com/solar-rebates-and-incentives/california/

Colorado State University & ICF International. (2011). Greenhouse Gas Emissions from U.S. Agriculture and Forestry: A Review of Emission Sources, Controlling Factors, and Mitigation Potential. Retrieved from http://www.usda.gov/oce/climate_change/techguide/Denef_et_al_2011_Review_of_reviews_v1.0.pdf

County of San Luis Obispo. (2014). Building and Construction Ordinance. Retrieved from: http://www.slocounty.ca.gov/Assets/PL/Ordinances/Title_19_Building_and_Construction_Ordinance.pdf

County of San Luis Obispo. (2016). Affordable Housing standards. Retrieved from: http://www.slocounty.ca.gov/Assets/PL/Housing/AHS/AHS.pdf

Curcija, C., Goudey, H., Mitchell, R., Dickerhoff, E. (March 2013). Highly Insulating Window Panel Attachment Retrofit. Retrieved January 30, from http://www.gsa.gov/portal/mediaId/180787/fileName/HiR_Panel_FullReport_6-13-13_508.action

Dairy Science Departments. Pasadena, CA: Nettie R. Drake. Retrieved from: https://cpslo-my.sharepoint.com/personal/agreve_calpoly_edu/Documents/CRP%20410/Eric%20Veium%20Documents/2009%20Chevron%20Biomass%20Cogen%20Study/Final%20Ltr%20to%20KCasey%20re%20CP%20manure%20feedstock%20021809.pdf

Drinking Solutions. (2015). Retrieved February 14, 2016, from http://Drwww.elkay.com/bottle-filling-stations

Earth Observatory. (*n.d.*). The Impact of Climate Change on Natural Disasters. Retrieved on January 13th, 2016, from http://earthobservatory.nasa.gov/Features/RisingCost/rising_cost5.php

Elliot, D. (2011, December). Energy Efficiency Partnership Program Best Practice Awards Application Form: California Polytechnic State University: San Luis Obispo. Retrieved January 31, 2016 from https://afd.calpoly.edu/sustainability/docs/awards/2012_water_efficiency_and_site_water_quality_nomination.pdf

Elliot, D. (2015). Cal Poly State University San Luis Obispo 2015 Drought Response Plan. Cal Poly. Retrieved 1/20/16 from https://afd.calpoly.edu/sustainability/docs/drought%20response%20plan%202015.pdf

Elliot, D. (2015, November 11). In-Class Water Resources Conversation [Personal interview].

Elliot, D. (Fall 2015). [Personal interview].

Energy Star. (*n.d.*). History of Energy Star. Retrieved from: https://www.energystar.gov/about/history

Environmental and Energy Study Institute. (*n.d.*). Building and Climate Change. Retrieved January 27, 2016, from http://www.eesi.org/files/climate.pdf

Envirnomental Protection Agency (EPA). (2005). *Carpool Incentive Programs*. Washington DC: author, 19 p.

Executive Order 987. (August 2, 2006).

Exploring California's Climate Change Research. (2016). Retrieved November 14th, 2015, from http://cal-adapt.org/

Facility Management and Development. (2014). Campus Operations. Retrieved February 11, 2016, from https://afd.calpoly.edu/sustainability/campusoperations.asp

Facility Management and Development. (2014). Planning, Design and Construction. Retrieved January 27, 2016, from https://afd.calpoly.edu/sustainability/planning.asp

Facility Management and Development. (2014). SUSTAINABILITY FOR CAL POY FACILITIES & OPERATIONS. Retrieved February 13, 2016, from https://afd.calpoly.edu/sustainability/docs/metrics/2014_sustainabilityreport.pdf

Facility Management and Development, Facilities Planning, Capital Projects. (2014). Sustainability Report. Retrieved October 16, 2015, from https://afd.calpoly.edu/sustainability/docs/metrics/2014_sustainabilityreport.pdf

Falkenstein, L. (2010, January 9). UW campus finally gets a grocery store with Fresh Madison Market. Retrieved February 27, 2016, from http://isthmus.com/food-drink/uw-campus-finally-gets-a-grocery-store-with-fresh-madison-market/

Federal Emergency Management Agency. (1998). Costs & Benefits of Floodproofing Methods. Washington, DC: Federal Emergency Management Agency.

Federal Emergency Management Agency. (2012). National Flood Hazard Map. San Luis Obispo. Retrieved January 30, 2016, from;http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30&extent=-120.6811236351318,35.28450703819111,-120.62499036486821,35.30762454659401

Fosdick, Judy. (2012). Passive Solar Heating. Retrieved from: http://wbdg.org/resources/psheating.php

Green Campus Program. (*n.d.*). Energy Competition Total Savings. Retrieved on March 4, 2016

Grocery Store Manager Salary (United States). (2016, January 12). Retrieved February 27, 2016, from http://www.payscale.com/research/US/Job=Grocery_Store_Manager/Salary

Gulland, John. (2008). Make Electricity While You Exercise. Mother Earth News. Retrieved on February 28th, 2016, from http://www.motherearthnews.com/renewable-energy/pedal-powered-generators-zmaz08onzgoe.aspx

Harnoto, M. F. (2013, Spring). A Comparative Life Cycle Assessment of Compostable and Reusable Takeout Clamshells at the University of California, Berkeley. Retrieved February, 2016, from http://nature.berkeley.edu/classes/es196/projects/2013final/HarnotoM_2013.pdf

Horton, J., & Kiger, P. (2008). 10 Wacky Forms of Alternative Energy. Retrieved January 13, 2016, from http://science.howstuffworks.com/environmental/green¬science/five¬forms¬alternative¬en ergy.htm

Hostick, R. (2015, November 12). Cal Poly Landscaping Practices [Personal interview].

HPS Mechanical. (*n.d.*). More successful HPS projects throughout California. Retrieved January 21, 2016, from http://www.hpsmechanical.com/past_projects.php

Hubbell Incorporated. (*n.d.*). University Students Fund Occupancy Sensors and Energy Savings. Retrieved January 31, 2016, from http://www.hubbell-wiring.com/press/pdfs/OccupancySensors_UniversityofIllinois.pdf

James, M. (2015). Net Zero Energy Buildings Passive House + Renewables. Retrieved on January 28, 2016, from, http://naphnetwork.org/NAPHN_NZEB_2015/Flipbook_Pro.html Solar Power Now. (*n.d.*). Cost Of Solar. Retrieved January 27, 2016, from http://solar-power-now.com/cost-of-solar/

Jon. (2014). Red brick competition motivates students to spend energy on conserving energy. Mustang News. Retrieved from March 5th, 2016, from http://mustangnews.net/red-brick-competition-motivates-students-to-spend-energy-on-conserving-energy/

List, Kevin. (2014). Living Green (or Gold) at Cal Poly. Retrieved on February 14, 2016 from http://mustangnews.net/wow-cal-poly-green-procedures/

Lucid Design Group. (2015). Building Dashboard: Cal Poly Fremont Hall. Retrieved on February 14th, 2016 from http://buildingdashboard.net/calpoly/#/calpoly/fremont

Luum (2015). 2015 Ride in the Rain Challenge. Retrieved on January 30, 2016 from http://www.luum.com/challenges/101/2015-ride-in-the-rain-challenge

Maehlum, M. A. (2015, March 23). How Much Do Solar Panels Cost. Retrieved February 15, 2016, from http://energyinformative.org/solar-panels-cost

Margoni, L. (2013). More Power To You: Ensuring a Reliable, Safe and Secure Supply of Energy at UC San Diego. Retrieved January 13, 2016, from http://ucsdnews.ucsd.edu/pressrelease/more_power_to_you_ensuring_a_reliable_safe_ and_secure_supply_of_energy_at_utPolyCAPBackgroundRpt2.pdf

McCarthy, C. (2016, February 18). Study finds most Campus Dining food unhealthy. Mustang News. Retrieved February 28, 2016, from http://mustangnews.net/majority-of-campus-foods-unhealthy/

Nevada Policy Research Group. (2014). Transparent California. Retrieved February 16, 2016, from http://transparentcalifornia.com/

Noriega, Christina. (2014). Two Solar-Powered Charging Stations Installed on Campus. The Daily Texan. Retrieved on February 28th, 2016 from http://www.dailytexanonline.com/2014/07/30/two-solar-powered-charging-stations-installed-on-campus

North Carolina State University. (2010). Effects of Climate Change on Agriculture. Retrieved from: http://climate.ncsu.edu/edu/k12/ClimateChange-Ag

Outdoor Foundation. (2013). Outdoor Participation Report. Retrived on February 21, 2016 from http://www.outdoorfoundation.org/pdf/ResearchParticipation2013.pdf

Pacific Institute: Research for People and the Planet. (2007, February). Retrieved March, 2016, from http://pacinst.org/publication/bottled-water-and-energy-a-fact-sheet/

Pedal Power. (*n.d.*). Big Rig. Retrieved from: http://pedal-power.com/products/big-rig

Public Works and Utility Department. (2013). WaterLab! Partnership between the City of Watsonville and UCSC. Watsonville Patch.

Redfield, J. (2014, July 14). The connection between microgrids and energy efficiency. Retrieved January 31, 2016, from https://www.nextenergy.org/jean¬redfield¬president¬ceo-nextenergy¬the¬connection¬between¬microgrids¬and¬energy¬efficiency/

Riggs, B., & Greve, A. (2013). Cal Poly GHG Inventory Calculations. Retrieved January 15, 2016.

Riggs, W., Knox, L., & Schwartz, J. (2015). Cal Poly 2015 Transportation Survey Report: Facts & Talking Points (Rep.). San Luis Obispo, CA: California Polytechnic State University. Retrieved from https://polylearn.calpoly.edu/AY_2015-2016/pluginfile.php/232355/mod_resource/content/1/CalPoly%202015%20Transportation%20Survey%20-%20Final2.pdf

Roth, B. (2015, October 28). Campus Water Stations Save 400,000 Plastic Bottles. Retrieved February 14, 2016, from https://today.duke.edu/2015/10/hydrationstations

Sacramento Council of Governments (*n.d.*). Bicycle Commute Guide. Retrieved on January 31, 2016 from http://www.peoplepoweredmovement.org/site/images/uploads/BicycleCommuteGuide_Sacramento.pdf

Sacramento, CA: California Stormwater Quality Association.

San Luis Obispo residents to CSU: Cap enrollment at Cal Poly. (2016, January 24). Retrieved February 14, 2016, from http://www.sanluisobispo.com/news/local/article56419725.html

Solar Power Now. (*n.d.*). Cost of Solar. Retrieved January 27, 2016, from http://solar-power-now.com/cost-of-solar/

Statista. (2016). Average per store number of FTEs of U.S. supermarkets 2013. Retrieved February 27, 2016, from http://www.statista.com/statistics/240965/average-per-store-number-of-ftes-of-us-supermarkets/

Student Government of The University of Texas at Austin (2011) SURE Walk. Retrieved on January 30, 2016 from http://utsg.org/projects/sure-walk/

SunRun. (2015). The Price of Residential Solar Power. Retrieved January 20, 2016, from http://www.sunrun.com/solar¬lease/cost¬of¬solar

Supermarket Facts. (2016). Retrieved February 11, 2016, from http://www.fmi.org/research-resources/supermarket-facts

Terra Blue Inc. (2012). Terra Blue Inc. Environmental Technologies. Retrieved from: http://terrablueinc.com

The Association for the Advancement of Sustainability in Higher Education. "Campus Car Bans." AASHE. AASHE, 2005. (2016, January 20). Retrieved on January 20. 2016 from http://www.aashe.org/resources/campus-car-bans

The California Polytechnic State University Greenhouse Gas Inventory. Cal Poly Facility Management and Development, City and regional Planning Department. (2016). Retrieved on March 01,2016, from https://polylearn.calpoly.edu/AY_2015-2016/pluginfile.php/388260/mod_resource/content/1/DraftGHGInventory.PolyCAP.pdf

Transparent California. (2015). California State University Facilities Salaries. Retrieved on February 15th, 2016 from http://transparentcalifornia.com/salaries/search/?a=california-state-university&q=facilities&y=2014

Transparent California. (2015). California State University Faculty - Academic Year Salaries. Retrieved on February 27, 2016 from http://transparentcalifornia.com/salaries/search/?a=california-state-university&q=Lecturer+-+academic+year&y=2014&page=2

Transparent California. (2015). California State University Health Salaries. Retrieved on February 15th, 2016 from http://transparentcalifornia.com/salaries/search/?a=california-state-university&q=health&y=2014

Trulia. (2016). Median Listing Price. Retrieved from http://www.trulia.com/home_prices/California/San_Luis_Obispo_County-heat_map/

U.S. Census. (2016). Median Average Square Feet of Floor Area. Retrieved from: https://www.census.gov/construction/chars/pdf/mfu_medavgsqft.pdf

U.S. Department of Energy. (*n.d.*) Energy Star. Retrieved from: http://energy.gov/eere/buildings/energy-star

U.S. Department of Transportation. (2015). 5 Strategies to Reduce Greenhouse Gas Emissions from Transportation Sources. Transportation and Global Climate Change: A Review and Analysis of the Literature. Retrieved on January 29, 2016 from http://www.fhwa.dot.gov/environment/glob_c5.pdf

U.S. Green Building Council. (2015, February 23). Green Building Facts. Retrieved January 27, 2016, from http://www.usgbc.org/articles/green-building-facts

United States Department of Energy. (2011). Building Energy Data Book. Retrieved from: http://buildingsdatabook.eren.doe.gov/docs%5CDataBooks%5C2010_BEDB.pdf

University at Buffalo. (*n.d.*). Solar Strand ¬ UB Sustainability. Retrieved January 13, 2016, from http://www.buffalo.edu/sustainability/solar¬strand.html

University of California, San Diego (2015). UC San Diego Launches Black Academic http://www.ucsd.edu/

US Flood Control Company. (*n.d.*). Flood Protection Products: Tiger Dams. Retrieved February 15, 2016, from http://usfloodcontrol.com/tiger-dam-products/

USDA. (2008). A Comparison of Grazing Behavior Between Desert Adapted Mexican Criollo Cattle and Temperate British Breeds Using Two Diverse Landscapes In New Mexico and Chihuahua. Retrieved from: http://www.leanandtenderbeef.com/PDF/USDA_Criollo_Grazing_Study.pdf

Vegetal I.D. (*n.d.*). Green Innovations for Smart Cities. Green Roof Benefits. Retrieved January 30, 2016, from; http://www.greenroofs.org/index.php/about/greenroofbenefits

Veium, E. (Fall 2015). [Personal interview].

Veium, E. (Received February, 2016). Ozzi Reusable Analysis.

Weather Underground. (2016). Solar Calculator. Retrieved from: http://www.wunderground.com/calculators/solar.html

Wilson, Marianne. (2013). Costs Going Up, Annual Study Tracks Cost of Building and Outfitting Stores. Retreived on February 14, 2016 from http://www.chainstoreage.com/sites/chainstoreage.com/files/ConstructionSurvey_2013.pdf

Wilson, Nick. (2016). Cal Poly Plans to Build On-Campus for Faculty and Staff. Retrieved from: http://www.sanluisobispo.com/news/local/education/article55847735.html

WrightGrid. (*n.d.*). Model Z. Retrieved on February 28th, 2016, from http://www.wrightgrid.com/model-z/

Yeo, G. (Fall 2015). [Personal interview].

CAP